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EAR WORM INJURIES TO CORN AND RESULTING LOSSES

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After reading practically all of five hundred and twenty-five references to the corn ear worm (*Chloridea obsoleta* Fab.) in literature, it has been observed that two serious sources of loss due to the activities of this well known pest have been overlooked. A brief discussion, therefore, of the various types of injury to corn caused by this insect, with observations from last year's study may prove of some practical value.[1]

It is well known that in most of the ear worm territory, the first generation of moths frequently oviposit on the unfolding leaves in the heart of the young corn plant. The larvæ upon hatching attack the tender leaves (Pl. 11, fig. 1) eating large and irregular holes in them. This injury has been variously designated in different localities as "rag worm" injury (Virginia), "shatter worm" (North Carolina), "heart worm" and "bud worm" injury (general). It would appear that there must be some injury to the vitality of the young corn plant though a few injured stalks under observation at this laboratory apparently overcame this injury and produced ears entirely comparable to stalks not thus injured and under the same growing conditions. Ear worm larvæ have several times been reported as boring into the stalk (Caudell, 1902),[2] but this habit is apparently unusual according to our observations.

The developing tassels are next attacked by the larvæ (Pl. 11, fig. 2). In this locality nearly grown larvæ are usually found doing this injury and in the few days' eating do considerable damage to the developing

[1] Acknowledgment is made to Mr. W. J. Phillips in charge of this laboratory for suggestions and criticism of this paper.

[2] Caudell, A. N. Notes on Colorado Insects. Bul. 38, N. S. Div. of Ent., U. S. Dept. of Ag., November 1902, p. 38.

staminate flowers. Were this feeding habit more frequent, a serious loss of pollen might result. A plat of two acres of field corn in which tassels were appearing July 3, 1918, was examined carefully and only ten tassels found to be thus injured. Since corn produces an excess of pollen, the loss of a few anthers is not serious.

By far the more important losses due to ear worm activity come from the attacks on the ears. It is well known that ear worm moths oviposit in the majority of cases on the fresh silks. The larvæ, upon hatching and after devouring the empty egg shells, begin at once to feed on the fresh silks. Sometimes the larvæ crawl down the silk strands well into the tip of the ear at once but not infrequently they feed more or less exposed on the silk at the tip for several instars (cf. Headlee, 1913).[1] Perhaps the most frequent type of silk injury is where the larva severs the strands some distance below the ends of the husks (Pl. 11, fig. 3). This condition is so frequent that a slight pull of the silk mass will generally indicate infested ears. If a part or all of the silk pulls out readily, ear worm work with but a few exceptions is assured. Where the silk does not yield, the husk must be opened to ascertain infestation.

Since it is through the silks or styles that the ovules are fertilized resulting in the development of the kernel, severance of the silk before fertilization will result in the absence of kernels on that part of the ear. It has been observed that the silks leading to the basal portion of the ear develop first and those to the tip, last. Dr. W. A. Taylor of the Bureau of Plant Industry, when asked for confirmation of this statement wrote (*in littera*), "the silks usually arise from a point an inch a two from the base of the ear. From this point the silking proceeds toward the tip and less rapidly towards the base. The last silks to emerge are from the tip of the ear." It appears that fertilization takes place over the greater part of the ear before ear worms reach the silks but some four or five days are necessary to fully pollinate a single ear of corn (Coulter, 1913).[2] Within this time ear worms enter the silk mass, sever some and thereby prevent fertilization of the tip ovules in which case a nubbin results (Pl. 11, fig. 8). Occasionally some kernels missing at the base of the ear may be explained in the same way but this is less common apparently than poorly filled out tips. The silks to the tip ovules are, in general, in the center of the silk mass. The larvæ appear to enter the ear generally through the center of the silk mass, eating as they go. If the larva merely eats in the external silk mass,

[1] Headlee, T. J. Rept. of the Entomologist. N. J. Station Rept., 1913, pp. 633–789, pls. 4, fig. 3.

[2] Coulter, John M. Elementary Studies in Botany. D. Appleton and Co., N. Y. 453 pp., 97 figs. (Corn, 343–351.) 1913.

as is not infrequent, fertilization may not be prevented for as Dr. Taylor further writes, "any portion that emerges beyond the husk is receptive." There are other well known sources of nubbins, but no record has been found of this one in literature. Observations here and in North Carolina indicate that it is of frequent occurence.

The fourth source of loss is the kernels actually eaten (Pl. 11, fig. 7). This varies from a fraction of one per cent to perhaps twenty-five per cent. The number of ears damaged here and southward is frequently 100 per cent.

The larvæ living in the ears and devouring the kernels scatter excrement in the damaged areas to the extent that a repulsive and unsightly condition results (Pl. 11, fig. 4). In the case of sweet corn, many ears are rendered totally unfit for food. Sometimes the damaged portions can be cut off and the ears then used but such ears are manifestly less desirable than uninjured ones. Here is a source of loss of especial importance to growers of sweet corn. Ears of field corn, ear worm-damaged, are usually fed to stock. Haslam (1910)[1] found bacteria of the *Aerogenes* group in this excrement which is recorded as being fatal usually to horses and rabbits when injected into their veins. Such corn is less attractive than perfect ears though the public appears to be largely reconciled to corn thus damaged. The corn exhibited at the corn show at Statesville, N. C., November 23, 1918, manifestly the choice ears of the various crops represented, showed 62 per cent of the ears ear worm-damaged.

Following the ear worm activity on soft corn appear various molds (Pl. 11, fig. 6). These molds not only detract from the appearance of the corn but render the parts thus attacked undesirable for food. Haslam (1910) and others found that symptoms of blind staggers result from feeding moldy corn to horses. *Aspergillus flavus*, *Aspergillus niger*, and *Rhizopus nigricans* are mentioned in this connection. Twenty-four ear worm-damaged ears of field corn, which had been invaded by molds, were submitted to Dr. W. A. Taylor for determination of the molds and the following genera were reported: *Penicillium* (13 ears), *Fusarium* (12 ears), *Cladosporium* (10), *Acrostalagmus* (7), *Rhizopus* (3), and *Verticillium*, *Macrosporium*, *Tricothecium*, *Oospora* (1 each). Though much study remains to be done on the effect of the toxic properties of these and similar molds on domestic animals, it is known that stock, especially horses, sometimes die as a result of being fed on moldy corn.

A seventh source of loss has been entirely overlooked. A very few writers state that ear worm larvæ continue eating corn after it hardens,

[1] Haslam, Thos. P. Meningo-Encephalitis. Kans. State Ag. College Exp. Sta., Dept. of Veterinary Science, Bul. 173, pp. 235–253. 1910. Bib.

the majority, however, failing to mention this feeding habit. A few other writers state that the larvæ forsake the hardening ears for alfalfa, weeds, etc. This latter condition perhaps varies with the locality but here, only a small proportion of the larvæ leaves the hardening ears. Most of the larvæ, especially those half grown and larger, continue feeding on the hardening kernels but their feeding changes in character. In soft corn the entire kernel is devoured (Pl. 11, fig. 7) but this is rare in hard corn. The endosperm part of the kernel hardens first, the germ remaining relatively soft up to harvesting time. The larvæ, therefore, eat the lower part of the kernels, the germ part (Lintner, 1881),[1] often tunneling through a dozen or more (Pl. 11, figs. 4, 9). With the lower part of the kernel gone, the attachment to the cob is also gone so that, during the husking and subsequent handling, these kernels drop out. If the shelled corn under a pile in the field is examined, sometimes as many as one fourth of the kernels will be found to he thus injured. A few more are dislodged when the corn is poured into the wagon as will be seen by examining the shelled corn in the wagon bed. Here is a source of injury often accounting for missing kernels at the tip of the ear and resulting in a complete loss. When the larvæ eat the endosperm of hard kernels, the kernel is largely reduced to corn meal as pointed out by Claypole[2] (1880), also resulting in a total loss.

Finally as French[3] (1882) and many others have indicated, the holes made in the husks by ear worms (Pl. 11, fig. 5) serve as entrance places for other insects which in some cases do considerable damage. In this connection the grain weevils of the south deserve especial mention. Other insects, largely *Coleoptera* and *Diptera* may be found living in the worm excrement and decaying or fermenting kernels which are of lesser economic importance.

It is a difficult matter to weigh in their proper proportions these sources of loss due to ear worm activity. In the light of these considerations there appears to he little douht that the ear worm is one of the major corn pests at the present time.

Explanation of Plate 11

1. An example of "rag worm" injury by the ear worm showing typical damage to the heart leaves.

2. Nearly grown ear worm larva devouring the developing tassel of the stalk of field corn.

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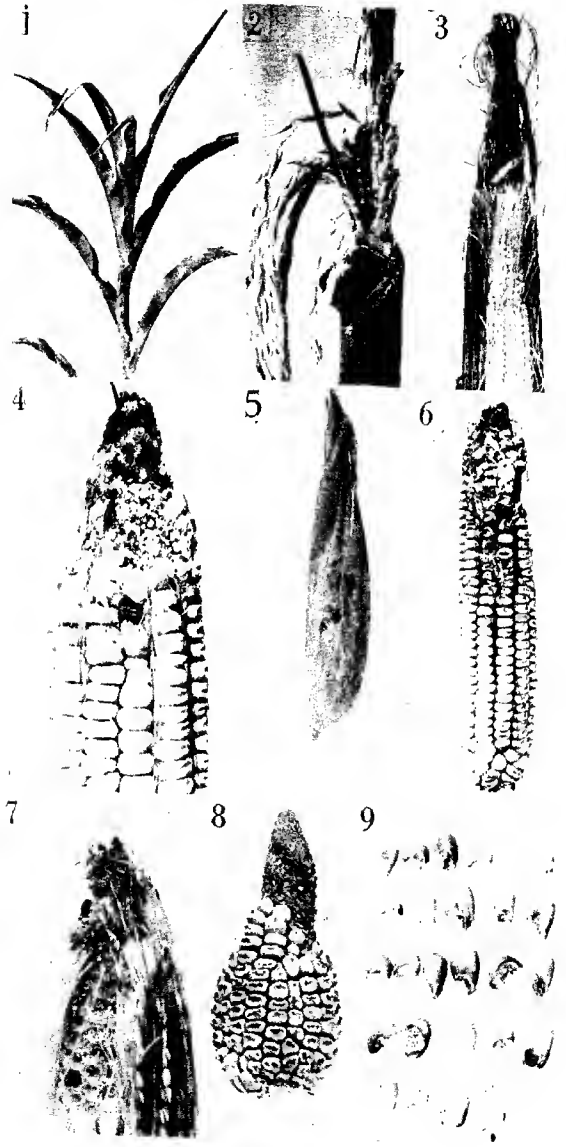
[1] Lintner, J. A. The Corn Worm, *Heliothis armigera*. *Cultivator and Country Gentlemen*, November 24, 1881. Vol. 46, p. 759.

[2] Claypole, E. W. *Heliothis armigera* Feeding on Hard Corn. Amer. Ent. 3 (n. s., vol. 1): 278. 1880.

[3] French, G. H. The Corn Worm or Boll Worm. In the 11th Rept. of the Noxious and Beneficial Insects of Ill., by State Entomologist of Ill., pp. 65–104. 1882.



Ear Worm Injuries

3: Large ear worm larva in tip of ear of sweet corn. Note that many silks leading to tip ovules have been severed.

4. Ear of hardened field corn with its tip ruined by ear worm. Note larval excrement and partly visible ear worm eating the germ part of the kernels.

5. Hole in husk of field corn through which ear worm larva left the ear.

6. An ear of white field corn showing serious side and tip ear worm injury which has been invaded by molds.

7. Severe ear worm injury to tip of ear of Stowell's Evergreen sweet corn showing excrement of larva and how entire kernels are devoured when corn is soft.

8. Nubbin of white field corn apparently caused by ear worm preventing fertilization by destruction of silk. Note furrow on tip of cob where ear worm almost encircled the same, severing the silks as it went.

9. Series of hard kernels of field corn showing ear worm preference for the germ part of the kernel. All kernels shown dropped from the ear when husked or handled.

NOTES ON THE LIFE HISTORY OF THE PINE TUBE MOTH[1] (EULIA PINATUBANA KEARFOTT)

By Albert Hartzell, *Ames, Iowa*

The presence of the larvæ of this insect in injurious numbers on white pine (*Pinus strobus* L.) in the vicinity of Ithaca, N. Y., offered an opportunity to study the habits of this interesting species. The work was done under the direction of Prof. Robert Matheson of Cornell University to whom the writer is deeply indebted for suggestions and criticisms. At the time the work was begun very little was known regarding the life history of the pine tube moth which, until 1905, had been confused with a European species, *Eulia politana* Haw., of widely different habits. The first reference to the pine tube moth was by Comstock[2] in the report of the United States Department of Agriculture for the year 1880. In 1905, Kearfott[3] recognized it as a new species under the name of *Eulia pinatubana*.

The Moth

The adult is a small trim moth with a wing expanse of about 14 mm. The head, fore wings, and thorax are of a rust-red color. The fore wings have two lighter oblique lines crossing them; the hind wings and the dorsal side of the abdomen are silky gray.

The first moth reared by the writer emerged April 13, 1915. The moths continued to emerge under insectary conditions until April 20. From examination of the pupal cases, emergence is accomplished by the splitting of the pupal thorax along the median line, usually as far

[1] Contribution from the Entomological Laboratory of Cornell University.

[2] 1881. Comstock, J. H. Report of U. S. Comm. Agr., 1880, p. 264–265.

[3] 1905. Kearfott, W. D. Canadian Entomologist, 37: 9–10.

caudad as the first segment of the abdomen. On the ventral surface the rupture is between the maxillæ and the first thoracic pair of legs, thence along the suture between the antennæ and the wing pads.

The moths were first observed in the field by the writer on April 30, 1915. In 1916 they were first seen on April 17. Specimens were captured June 8, 12, 19, and July 15, 1915, and April 17, 1916. All the observations and captures were made at Ithaca, N. Y. In spite of the large number of tubes found on white pine in this vicinity the moths are seldom taken.

Our observations indicate that the moths are crepuscular. In the day time they appear sluggish while at dusk they become active and are extremely hard to follow because of their zig-zag flight. In experiment cages they avoided the intense light of an electric bulb but appeared to be attracted to a mild light. Several trips were made to a near-by pine wood to study their nocturnal habits under natural conditions but the moths were never observed flying except when disturbed. The writer never succeeded in capturing them with trap lanterns. The average length of life as appears from data at hand is approximately eight and one-half days.

Mating and Egglaying

The moths could not be reared in sufficient numbers to make a careful study of their mating and egglaying habits. Copulation was observed once, however, and the time occupied was ten minutes. Females confined to cages were frequently seen pressing the tip of the abdomen against the rib of the pine leaves but all attempts to rear the larvæ from the eggs failed. The writer confirmed the identification of the eggs, however, by the dissection of gravid females.

Description

The Egg.—The egg is translucent, slightly pointed at the apex and rounded on the opposite side. The average length is 4 mm.; width, .58 mm.

The Larva.—The shape of the mature larva is roughly cylindrical; length 8 times the width; color greenish-yellow with an indistinct darker green band along the dorsal median line. The head is greenish-brown and is semi-translucent. The patch on the side of the head is dark brown to black. The head is not depressed. The front extends about three-fourths the distance to the vertical angle. The second adfrontal setigerous puncture is present. There are six ocelli; the second and fourth are larger than the others. The sixth is rather close to the fourth and fifth. Prolegs on the 3rd, 4th, 5th, 6th and 10th abdominal segments. The seta on the distal end of the anal process is at least twice the length of the stalk of the anal process.

Habits of Larvæ

The larvæ are active caterpillars. When disturbed they retreat into their tubes; if unable to return they will let themselves down by

means of a thread spun from the silk glands. Because of their shyness, minute size and protective coloration they are difficult to study in the field.

The larvæ build tubes by drawing together the leaves of the white pine with silk. The leaves are placed longitudinally side by side and are bound together by means of silken threads. From five to twenty leaves are used in its construction. At first the tube consists of five leaves, the number in a single fascicle, but as the larva grows more and more are drawn in to feed upon. Usually two or three are left uneaten which serve to hold the tube in place even when many of the older leaves that constitute it are dead. The larvæ live singly. It was thought probable that the caterpillars may occupy more than one tube during its larval life. From the beginning of the study the writer had noticed that pupæ were commonly found in new tubes. In order to prove that a caterpillar may occupy more than one tube during its larval life, a larva of the last instar was removed from its tube and placed on a pine branch. In a few days the branch was examined and on it was a roughly constructed tube which the larva hastily made prior to pupating.

The first larvæ were observed in the field July 20, 1915. At that time they were 3 mm. in length. The head measurements varied from .282 mm. in the first instar to .848 mm. in the sixth instar.

The Pupa

The pupal skin at first is soft and pliable. The color is greenish-yellow, resembling that of the larva. In eight or ten days the skin hardens and turns brown with a green tint along the wing pads and thorax. Specimens examined October 20, 1915, showed structural resemblances of the mature pupa except that in a number of cases the antennæ were more sharply defined than in the mature specimens.

The pupæ are found in October in the upper ends of the tubes, enveloped in silk. The insect hibernates in the pupal state. That the insect may not invariably pass the winter as a pupa was brought to the writer's attention by the discovery of a live larva in a tube on December 23, 1916.

Number of Generations

It is commonly believed that a second generation occurs in the latitude of central New York. The data gathered in this study indicates that the insect is singly brooded, but more research is needed to establish this fact.

Distribution

The distribution of the pine tube moth is not very well known. Comstock[1] reports that it occurs as far south as Florida; Kearfott,[2] from New Jersey and Ontario, and Packard[3] from Massachusetts and Maine. Probably it is safe to conclude that *Eulia pinatubana* occurs throughout the white pine district of southern Canada and eastern United States.

Host Plants

During this study an examination of the various species of pine in the vicinity of Ithaca, N. Y., was made to determine whether white pine is the only host plant of the larvæ of the pine tube moth. Our observations lead us to conclude that white pine (*Pinus strobus* L.) is the only host plant. Fernald[4] has called attention to the fact that the European *Eulia politana* has never been reported from a single conifer in Europe.

Natural Enemies

In connection with this study twenty-five individual parasites have been bred. A list of these parasites is given in the table, with the dates of emergence. Through the kindness of Dr. L. O. Howard, chief of the Bureau of Entomology, five have been identified to genera and twenty to species. The Chalcids were identified by Mr. A. A. Girault. The remaining parasites were identified by Mr. R. A. Cushman and Mr. S. A. Rohwer. Of the total number seven are larval and eighteen are pupal parasites.

Pupal Parasites

The pupal parasites were bred in connection with the rearing of the adults. In order to breed the moths successfully it is necessary that the pupæ remain undisturbed in the tubes. Mr. Cushman calls attention to the fact that *Eclytus pleuralis* has previously been bred from spider nests and as the parasites in question were not bred from naked pupæ it is probable that they came from a similar source as the tubes are frequently the haunts of small spiders.

Larval Parasites

On October 18, 1915, while engaged in making head measurements of caterpillars the writer observed a larva that appeared sluggish. Thinking that this individual was ready to molt, it was placed in a

[1] 1914. Comstock, J. H., and Anna B. A Manual of the Study of Insects, p. 245.
[2] 1905. Kearfott, W. D. Canadian Entomologist, 37: 10.
[3] 1890. Packard, A. S. 5th Report, U. S. Ent. Comm., p. 791.
[4] 1881. Fernald, C. H. Report of U. S. Comm. Agr., 1880, p. 265.

vial. When examined two days later, nothing but the skin remained and in its place appeared a larval parasite that seemed to be sucking the juices from the remains of the host caterpillar. A second *pinatubana* larva introduced into the vial met with a similar fate. The parasite pupated October 29, 1915. On November 3, the adult appeared. Again on October 18, 1915, another caterpillar was found with two parasitic larvæ attached to the dorsum. October 22, one of the parasites was observed feeding on the host. Only one of these reached maturity. Both the adults referred to above were identified by Mr. R. A. Cushman as *Epiurus alborictus* Cress. These larvæ seem to attack the host just before pupation. It is not uncommon to see two or three eagerly devouring a sluggish caterpillar.

On October 25, 1915, another larva was found attacking a caterpillar. On the 29th of the same month a pupa unlike that of *E. pinatubana* was found in the tube occupying the same relative position as the host pupa normally assumes. It was necessary to open the tube and remove the silk to assure one that it was not the pupa of the pine tube moth. The parasite in question was identified by Mr. S. A. Rohwer as *Phytodietus pleuralis* Cress.

PARASITES OF EULIA PINATUBANA KEARFOTT

	Date of Emergence	*Parasitic on*	*Name*	*Identified by*
	1915			
1.	Apr. 13	pupa	Eurytoma sp.	A. A. Girault
2.	" 15	"	"	"
3.	" 16	"	"	"
4.	" 20	"	Elachistus sp.	"
5.	" 15	"	Epiurus indagator (Walsh)	R. A. Cushman
6.	" 16	"	Eclytus pleuralis (Prov.)	"
7.	" 16	"	" "	"
8.	" 16	"	Epiurus indagator (Walsh)	"
9.	Nov. 4	larva	Epiurus alborictus (Cress)	"
10.	Oct. 29	"	" "	"
11.	Dec. 3	"	Phytodietus pleuralis (Cresson)	S. A. Rohwer
12.	" 4	pupa	Itoplectis conquisitor (Say)	R. A. Cushman
13.	" 4	"	Phytodietus pleuralis (Cresson)	S. A. Rohwer
14.	" 19	larva	" "	"
15.	" 31	"	Hemiteles sp.	"
16.	" 31	pupa (?)	Epiurus alborictus Cr.	R. A. Cushman
17.	" 31	"	" "	"
	1916			
18.	Jan. 18	"	Phytodietus pleuralis (Cresson)	S. A. Rohwer
19.	Feb. 7	"	" "	"
20.	" 8	"	" "	"
21.	Apr. 1	"	" "	"
22.	Nov. 29	larva	" "	"
23.	Dec. 29	"	" "	"
24.	" 29	pupa (?)	Epiurus indagator Cr.	R. A. Cushman
25.	May 6	"	" "	"

OBSERVATIONS ON WINGLESS MAY BEETLES

By R. A. Vickery and T. S. Wilson

During the spring of 1918, from April to July, this station received many reports of damage to crops by the wingless May beetles. Two species were injurious, namely, *Lachnosterna cribrosa* and *Lachnosterna farcta*. The former was reported to be injurious to cotton in Bexar County and in other counties in southern Texas, and to wheat in northern Texas. The latter was reported to this station only from Bexar County, the most serious damage being done in and near the city of San Antonio. Both species are very destructive to crops when they occur in large numbers, as they attack young plants and may completely destroy all plants in a large field. Furthermore, they remain numerous long enough to destroy several plantings.

Lachnosterna cribrosa is about one inch long, shiny black in color and wingless. *Lachnosterna farcta* is about the same size but brown in color. The latter species has wings but they are too small to be used in flying. Both species have stout clumsy bodies with distended abdomens.

These beetles remain in the ground during the day and emerge only at night to feed. *Lachnosterna cribrosa* comes out about sundown and remains out for several hours but *L. farcta* comes out after dark and remains out a longer time. Both species are energetic travelers and may be seen wandering about after dark. Their choice of food is limited by their clumsiness and inability to fly, so that they eat almost any vegetation that they can reach. They seem best able to climb plants having small round stems, such as young plants of cotton, bean, Amaranthus, and alfalfa. They usually do not climb high upon the larger plants but feed on the more accessible lower leaves. Both species feign death when disturbed.

In the laboratory these beetles were kept in uncovered wooden boxes 30 inches in length, 16 inches in width, and 12 inches in depth, and they were seldom able to climb out. *Lachnosterna cribrosa* began to emerge from the soil in these boxes about 6.30 p. m., sun time, and had all reëntered the soil by 9.30, but *L. farcta* was still emerging at this hour.

The beetles burrow into the ground to a depth of from four to six inches. They usually enter near the base of the plant upon which they have been feeding. Many often enter near the base of one plant or of a small cluster of plants and they kick up a small mound of pulverized soil, giving the characteristic appearance as shown in figure 3, plate 13. The emergence holes are round and about one-half inch in

diameter which are plainly visible where the ground has not been pulverized by cultivation. Just before sundown *L. cribrosa* may often be observed sitting quietly with the head projecting out of the exit. These holes are shown in the photograph (Fig. 4, pl. 13). These beetles began to emerge in the field about sundown and by 9 o'clock they were out in countless numbers, sometimes as many as five to a single plant.

LACHNOSTERNA FARCTA

Reports began coming to our office during the latter part of March, 1918, from the people of San Antonio who had gardens attacked by the common large brown June beetle (*Lachnosterna farcta*). By the first of May these beetles were very numerous and the reports of damage were coming to us almost every day. The ravages of this pest were so great that many gardens were replanted several times, the plants being defoliated each time. The gardens in the northern part of the city suffered most.

Many acres of cotton were destroyed by this species in Bexar County and perhaps the damage extends into other counties. In four fields visited the cotton had been completely destroyed in areas of from five to twenty acres. Other fields were damaged in smaller patches.

In one field observed these beetles had finished a fifteen acre tract of cotton and attacked young corn adjacent to the cotton, but as the corn was too large to be destroyed only the lower leaves were damaged.

This species did not entirely disappear until about the middle of July. One beetle was observed in a garden in the northwest part of the city on the night of July 14, and one was caught in a barrier at the United States Entomological Laboratory on July 15.

FOOD PLANTS.—Beans seemed to be the favorite food plant of this species in the gardens. As many as four or five beetles fed on a single plant, eating off the leaves and buds and leaving only the stalk. Large numbers of these beetles were observed feeding on Bermuda grass in lawns and in vacant lots at the edge of the city. Among field crops cotton was the favorite. Young plants with two to four leaves were entirely defoliated, causing the stems to die soon afterwards. The older plants suffered considerable damage but were not killed outright. We observed the beetles feeding on corn in the station garden. They usually remained on the ground and fed on the lower leaves which hung down, although a few were observed climbing the young plants.

We observed these beetles feeding on the following plants: Amaranthus spp., beans, beets, Bermuda grass, black eye peas, corn, cotton, cabbage, castor bean, cucumber, fig, grape, lettuce, okra, radish, rape, Russian sunflower, rutabaga, spinach, turnip, and velvet bean.

People who cultivated small gardens reported that the beetles

attacked the plants listed below, besides many of those given above: English peas, eggplant, blackberry, cantaloupe, carrot, onion, peanut, potato, watermelon; and the following flowering plants: candytuft, chrysanthemum, cockscomb, columbine, cornflower, larkspur, marigold, petunia, pinks, poppy, rose, snapdragon, spearmint, sweet pea, verbena and zinnia.

Experiments with Control Measures.—When the complaints first began coming in we recommended the use of light traps. The lights were placed over vessels buried with the tops level with the surface of the ground, some dry and others containing water. Only a few of the beetles were caught by this method.

We also recommended hand-picking. This method has been used by many people in former outbreaks and is effective where only a few of the beetles can migrate into the garden. But it proved to be a tedious and useless remedy for a small garden surrounded by large lawns and vacant lands or other gardens from which the pest could migrate.

The use of bran mash or the application of arsenicals to the plants in powder form or liquid spray would be effective in large market gardens but could not be recommended for use in small gardens because poultry would often have access to the poison or the dead beetles.

We know of one man who protected his plants by means of empty tin cans with both ends removed and placed over the plants.

We found that a barrier made of boards could be used successfully for the protection of small patches of vegetables. Any kind of boards may be used but if narrow they should have one side smooth. The boards should be placed tightly on one edge on the ground with the ends fitting tightly. Vessels are buried with the tops level with the surface of the ground at intervals against the boards, both inside and outside. As the beetles wander about they come to the boards and follow them till they fall into the vessels where they remain. On account of their heavy, clumsy bodies they are able to climb even a rough perpendicular surface only a few inches. They have been observed many times trying to climb a board but nearly always falling back. In a few instances they have been seen to cross a four-inch board. It is impossible for them to escape from buried vessels which have smooth inner surfaces. After a few nights nearly all the beetles were caught from within the barrier but picking some by hand each night would more speedily rid the part inside the barrier from the beetles.

Barrier Experiments.—We constructed seven of these barriers in all as described above. They were all located in the southern part of the city near the laboratory where the beetles were not so numerous as they were in the northern part. The beetles were removed from

the traps every morning and the number recorded. The records of two of these barriers are given here.

Barrier No. 2: This barrier was constructed in a cotton patch in the laboratory garden on May 22, 1918. A plot 20 feet square was inclosed by means of boards 1 inch thick, 4 inches wide, and 20 feet long. On the inside one eight-inch flower pot was placed in each corner. Pots were not placed on the outside until May 23 when one was placed at the middle of each side, and on May 28 one was placed at each outer corner.

A record of the collections made at this barrier is given below. Beetles were collected from May 23 until July 15, 102 being caught on the inside and 953 on outside.

TABLE SHOWING NUMBER OF *Lachnosterna farcta* CAUGHT IN BARRIER NUMBER 2

Date 1918	Beetles Inside	Beetles Outside	Total	Date 1918	Beetles Inside	Beetles Outside	Total
May 23	35	0	35	June 19	0	0	0
24	8	90	98	20	0	1	1
25	4	97	101	21	0	5	5
26	4	65	69	22	0	1	1
27	2	73	75	23*	0	0	0
28	5	83	88	24	0	9	9
29	4	91	95	25	0	1	1
30	4	74	78	26	0	2	2
31	3	58	61	27	0	1	1
June 1	1	47	48	28	0	4	4
2	1	23	24	29	0	0	0
3	6	39	45	30	0	0	0
4	0	35	35	July 1	2	0	2
5	1	25	26	2	0	3	3
6	2	13	15	3	0	0	0
7	4	17	21	4*	0	0	0
8	4	13	17	5	0	1	1
9	2	14	16	6	0	0	0
10	4	17	21	7*	0	0	0
11	4	8	12	8	0	1	1
12	0	9	9	9	0	0	0
13	2	11	13	10	0	0	0
14	0	7	7	11	0	1	1
15	0	4	4	12	0	0	0
16*	0	0	0	13	0	0	0
17	0	5	5	14*	0	0	0
18	0	4	4	15	0	1	1
				Total	102	953	1,055

Observations were discontinued on July 23.

*No observations made.

Barrier No. 6: On July 3, 1918, a barrier was constructed around a bean patch, consisting of five rows 150 feet long, located in the south part of San Antonio. This barrier was made of boards 1 inch in thickness and 4 inches in width placed on one edge, fitting tightly on the surface of the ground. The ends were held together by means of pieces of shingle nailed on the top edges and the boards were supported

by pieces of shingle driven into the ground and nailed to the boards. Common tin cans were buried with the tops level with the surface of the ground and against the boards, both inside and outside the barrier. On the inside a can was placed at each corner and twelve cans were placed at intervals along each side. The same number of cans were put on the outside in the corresponding locations. Fifty-six cans were used altogether.

A record of the collections follows. Counts were made from June 4 until June 22, making a total of 371 beetles from the inside and 1,414 from the outside.

TABLE SHOWING NUMBER OF *L. farcta* CAUGHT IN BARRIER NO. 6

Date 1918		No. Caught Inside	No. Caught Outside	Total
June	4	96	109	205
	5	48	149	197
	6	37	137	174
	7	24	84	108
	8	27	72	99
	9	38	102	140
	10	22	62	84
	11	10	34	44
	12	4	40	44
	13	13	29	42
	14	6	20	26
	15	11	42	53
	16	6	40	46
	17	9	23	32
	18	4	16	20
	19	5	27	32
	20	2	29	31
	21	5	12	17
	22	4	16	20
Total		371	1,043	1,414

LACHNOSTERNA CRIBROSA

The first report of damage by this species was received on April 25, 1918, from Mr. Albert Gembler who has a farm about ten miles southeast of San Antonio on the Goliad road. The writers visited this farm and found these beetles there in very large numbers. The field where damage occurred comprises about seventy acres. The soil is loose, sandy loam upland and slopes toward the west and south. There is a strip of brush on the north side and cultivated fields on all the other sides of this field. Cotton was planted in this field and there was a good stand of young plants with from two to four leaves when the outbreak started. The beetles had started work in the highest part of the field and had destroyed the cotton plants in a solid patch of about fifteen acres. The devastated area was roughly circular in shape and it appeared that the beetles had matured in this part of the field.

They were working along the edge of this area and were migrating outward and destroying the cotton as they went. The cotton was planted in rows extending north and south and the beetles seemed to prefer to follow the rows as the heaviest migration was northward. Most of their fresh entrance burrows were found in a strip about five yards wide around the bare area. This strip was also marked by many newly damaged plants.

Here we found the beetles in the soil in very large numbers, often from 6 to 13 in one foot length of the cotton row. Beetles were found in all parts of the field in small numbers and a few in the brush on the north side of the field where they had probably migrated from the infested part of the field.

By the latter part of June the beetles had almost disappeared. It was estimated that a total of about forty acres of cotton was destroyed, aggregating a loss of about $2,000.

FOOD PLANTS.—These beetles were observed in the field feeding on cotton, beans, corn, and sorghum; and on Russian sunflower in the laboratory garden. In the laboratory cages they were fed on Amaranthus and alfalfa. Both of these plants were eaten readily. They ate of the corn leaves which were put into the cages but did not relish this plant. Cotton was the favorite food plant in the field. These beetles were sometimes seen nibbling on the leaves of young *Panicum fasciculatum reticulatum* Torr. However, this grass apparently did not suit their taste as the plants were left in the rows where the cotton had been completely destroyed.

EXPERIMENTS WITH CONTROL MEASURES.—Large quantities of the beetles were hand-picked at night and killed by means of kerosene by the Gembler family. But on account of the extremely large numbers this process was not only a tedious one but almost ineffective.

On April 25 we prepared three pounds of bran mash and scattered in this cotton field where the beetles were numerous. The mash was made according to the following formula:

Wheat bran	24 pounds
London Purple	1¼ pounds
Syrup	2 quarts

On the following evening several dead beetles were found in this spot on top and in the soil and several others apparently too sick to move or feed. In some instances the poison took effect after the beetles had entered the soil. More dead ones were found the second day after the poison was put out than the first day afterwards.

Two more batches of poison bait were put out on April 27, prepared according to the following formulæ:

Wheat bran	24 pounds
Paris green	1 pound
Oil of anise	1 ounce

Corn bran	24 pounds
Paris green	1 pound
Syrup	1½ quarts

This poison bait was put out about 6 p. m., scattered by hand in the cotton rows. At 9 o'clock a large number of beetles were feeding on the bait. Only a few were seen feeding on that made of corn bran but many on the wheat bran mash. Later observations showed that a large number of beetles were killed by the latter and only a few by the former.

Encouraged by the results of the previous experiments Mr. Gembler began putting out bait made according to the following formula:

Wheat bran	20 pounds
Paris green	1 pound
Syrup	1 quart
Lemons	3

He scattered twenty pounds of this mixture each evening about sundown as it was found that this was the best time because the material dried out rapidly. There seemed to be some advantage in mixing the bait the day before it was to be used, thus allowing the poison to become more thoroughly soaked into the bran. From two to three acres could be covered by twenty pounds of the bait. The best results were obtained by putting it in the patches where the beetles were most numerous as indicated by the exit and entrance holes.

Excellent results came from the use of this poison bait for large numbers of dead beetles were to be found where it was used. In some places from five to eight dead were found on top of the ground in a space the size of a man's hand. A large percentage also died after entering the soil and many were found dead where they had crawled several yards from where they had eaten of the poison. Twelve counts were made in different parts of the field, each count measuring twenty yards in length of the cotton row. The dead beetles in these spaces ranged from 15 to 60 in number, averaging 32 to each count. The records were made during the evening about 6 o'clock and only two of these places had live beetles, one had one and another three crawling about. These counts did not include those which had died after entering the soil.

Mr. Gembler substituted one teaspoonful of anise oil in some of the bait and according to his observations the species preferred it to that

flavored with lemon juice. He states that the beetles would often leave the cotton plants to feed on this bait.

A few rows of cotton were dusted with powdered arsenate of lead. A large number of the beetles were killed by this means also. But it was found that the arsenate of lead used as a spray, two ounces to three gallons of water, was more economical. This spray was used effectively to help stop the advancing pest, and thus saving part of the cotton. This and the poison bait saved several acres of cotton on one side of the field while on the other side, where poison was not utilized, it was destroyed to the fence.

During July we investigated damage done by *Lachnosterna cribrosa* in San Patricio County. We found that it had been numerous and had done serious damage to cotton there also. The following letter from Mr. T. C. Cobb, who is county agent of that county, tells of the methods used to combat the beetles. This letter bearing the date July 17, 1918, reads:

DEAR SIR:

Having had considerable experience this season in fighting wingless May beetles I am glad to report the results of the methods employed in this county.

In the first place I wish to state that the beetle was here in countless numbers, completely destroying in one instance a hundred-acre block of cotton, as well as doing considerable damage on smaller scale in several other fields.

We tried various methods, including poisoned bran mash, dusting poison on the cotton plants, hand-picking, but the best work was with the barrier ditches. These were made by running several times in the same furrow with a lister, making a loose steep-sided, deep furrow. The perpendicular-sided furrow was not successful because the beetles could climb out on the hard dirt, while the loose dirt would roll down with them when they tried to climb out of this. After plowing the furrow as deep as necessary with the lister the bottom was smoothed out with a shovel so the beetles could easily walk along the bottom. In this smooth part postholes were dug about fifteen or twenty feet apart, into which the beetles fell and were destroyed.

A little different plan than that which has been suggested is to leave off the digging of holes in the bottom of the furrow, and patrol the furrow with a pear burner during the time the beetles travel, which is only late in the evening. I believe this would be just as effective as any other method although we didn't try it this year.

There is no doubt that this beetle can be controlled so as to prevent serious damage with the barrier ditch if the work is done in time, and the beetle is coming into the cotton from outside. In case the beetle hatches in the cotton field I believe the bran mash poisoning would be the most effective means of control, several farmers in this county reporting absolutely satisfactory results from this method.

Yours very truly,

(Signed) T. C. COBB, *County Agent,*
San Patricio County, Texas.

Recommendations for Control of Wingless May Beetles

1. *In Gardens*

The use of a barrier is the only practical method of controlling these beetles in a small garden. This should be made as described under *Lachnosterna farcta*. In some cases where the beetles are known to come into the garden from one direction a barrier on that side will be sufficient with the aid of hand-picking at night. When the beetles are gathered they should be saved for the chickens. If it is necessary to buy lumber for the barrier, boards 1 by 4 inches and 20 feet long are cheapest and would be satisfactory. Tin cans, with the bottoms melted out, may be used to protect a few of the most valuable young plants. They should be placed over the plants about sundown and removed in the morning.

In large market gardens the seed beds should be protected by a barrier. The plants which are already started in the field should be sprayed or dusted with arsenicals. In case the beetles are very numerous the poison bran mash should be used. If a heavy migration from outside should occur, a deep furrow should be made and bran mash distributed on both sides of the furrow and among the plants nearest the furrow.

2. *In Field Crops*

When the outbreak originates in the field and the beetles are very numerous the infested area should be treated immediately with bran mash. This bait should be broadcasted all over the infested part. This can be done most easily by two men with a single horse and buggy or light wagon. Also a small quantity of the poison bait should be placed at each entrance hole or group of entrance holes at the edges of the infested area. The latter method should also be used where the beetles are scattered in small numbers throughout the field, for although the beetles may not be numerous enough to destroy the stand, it is important to get rid of them before they lay eggs. If the infested area is given one thorough treatment with the poison bait it should be safe to replant in case the stand has been destroyed. When the plants are larger, for instance cotton plants about six inches high, the arsenical should be applied directly to the plants. This could be done very economically with a horse-drawn traction operated potato sprayer, and would also give protection against such insects as *Feltia* spp., *Prodenia* spp., and *Loxostege similalis*.

Where it is desired to protect a field from a heavy migration of beetles, originating in an adjoining field, a furrow barrier should be made. Bran mash should be distributed on both sides of the barrier and among the plants near it. If the plants near the furrow are large enough to be poisoned an arsenical should be applied to them.

Fig. 1.

Fig. 2

Fig. 3.

Wingless May Beetles

Fig. 1.

Fig. 2

Fig. 3.

Fig. 4.

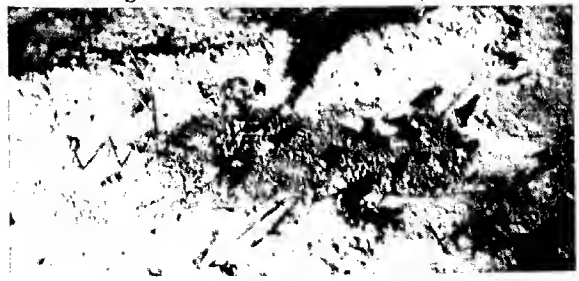


Fig. 5.

Wingless May Beetles Work

Explanation of Plates

Plate 12

Fig. 1. Barrier for the protection of plants from *Lachnosterna farcta* See text under Barrier No. 2.
Fig. 2. *Lachnosterna farcta*; x2.
Fig. 3. *Lachnosterna cribrosa*, x2.

Plate 13

Fig. 1. *Lachnosterna cribrosa* beetles finishing a few cotton plants.
Fig. 2. A defoliated plant and emergence holes of the beetles. One beetle just emerged.
Fig. 3. Shows a typical group of entrance burrows at the base of a cotton plant.
Fig. 4. Another view showing soil kicked up by the beetles when entering the ground and emergence holes of the beetles near three defoliated plants.
Fig. 5. Flashlight of the beetles at work on cotton plants.

JAPANESE FLOWER BEETLE

By W. H. Goodwin

Some ten miles northeast of Camden, and a few miles back from the Delaware River opposite Tacony, North Philadelphia, is the location where the Japanese flower beetle has become established, temporarily at least. The infested territory lies between Moorestown and Riverton, N. J., and at present covers some four or five thousand acres of very productive sandy loam farms. The country is gently rolling and the greatest altitude is not over one hundred feet above sea level. It is drained by small creeks but the entire area lies between the two larger streams, Pensauken and Rancocas creeks. Farming in this district is intensive; the principal crops, excepting for a small amount of general farm crops, are such truck crops as tomatoes, sweet corn, asparagus, peas, and beans, which find a ready market in the city. Peaches, apples, pears, and cherries do well in this locality and are quite extensively grown.

The soil varies greatly in texture and general mechanical composition, varying from a rather stiff heavy clay soil to almost pure sand. Sometimes these extremes in soil variation occur within the comparatively short distance of only a few rods.

These principal soils are known as Sassafras, Freneau, and Elkton loams with a few small areas of other types.

The people are largely Quakers and, I take it, are descendents of the early settlers of this district.

In April, 1918, final action was taken to begin active steps for the eradication of this newly acclimated pest, for pest it is, as the meager

reports from Japan class it as doing more general damage than any other species of the coleoptera in the Islands.

In New Jersey it has seemingly not lost its reputation as a pest.

From the survey made by Mr. W. O. Ellis, after the 18th of August, 1917, the range of territory occupied by this beetle was about 2,500 acres. This does not mean that the pest was actually established over this entire area, but beetles were collected at various points over an area of this extent.

Upon my arrival, May 1, 1918, the only equipment available for eradication work was a small cart sprayer, a barrel sprayer and two large D1 Model Niagara dusters and a ton of arsenate of lead.

Working plans were necessary and were prepared after carefully looking over the territory and the conditions which would be encountered.

Plans

First: To test soil fumigants and choose the best suited for the existing conditions. Procure the same in a sufficient quantity to treat all territory heavily infested with the larvæ of the Japanese flower beetle to destroy them.

Second: To place trap lights throughout the central portion of the district to trap the beetles. A translation from the life history, as given in the Japanese writings, states that they are caught by setting a lighted lantern in a pan of petrol.

Third: To destroy all uneconomic plants in so far as possible in a band around the infested territory, band to be about one half mile wide.

Fourth: To dust all food plants with poison, especially a broad band of territory surrounding the central portion of the infested district.

Fifth: To collect as many beetles as possible in nets.

Sixth: To test cultivation throughout the season and late fall plowing to determine its effect on the larvæ.

The plans for eradication work encountered many difficulties from the beginning. The equipment needed included a large sprayer, two large dusters, a tractor, a light truck, and necessary machines to get around over the territory and transport men and materials wherever required.

Intelligent labor of the type needed was difficult to secure. Horse-power was at a premium and very difficult to obtain at the times most needed.

A larval survey was necessary in order to determine the areas which should receive soil treatment to destroy the larvæ, meanwhile experiments were under way testing the efficiency of various soil fumigants. Sodium cyanide at the rate of 1 ounce in 15 gallons of water distributed over twenty-five square feet of ground gave the best results.

We (Mr. Ellis and I) were anxious to get the results and dug the test plots two to three days after treatment. A kill of 65 to 80 per cent resulted from this treatment.

Plots treated later on in the season (duplicate halves of others) in which the kill averaged to 60 to 65 per cent of all grubs 3 days after treated; when dug six to seven days after treatment gave an increase of approximately 15 per cent to 20 per cent in effectiveness, killing 80 to 90 per cent of the stages in soil.

The partial larval survey, made by C. A. Perry and myself, gave us ample territory that was heavily infested with larvæ to be treated but no materials or equipment had arrived by mid-June. Trap light towers were constructed, gasoline lanterns and pans were purchased and these were put in place through the central part of the district. Counts of beetles caught in the pans by the latter part of July gave an average of less than 20 beetles per lamp where the lamps were kept burning every night. Several towers fully equipped, but which did not have the lanterns lit on account of failing to catch beetles, averaged above 250 beetles per tower. The trap lanterns were a failure; some one had made a bad recommendation, if we can rely on the translation from the Japanese literature or else we have a change in habits of the beetles. Such things sometimes make one question species indentification.

As no more equipment or materials had arrived by June 20, 1918, steps were taken to get the eradication work under way. A Ford runabout had been purchased at New Brunswick and, through Dr. Headlee, we secured a small supply of sodium cyanide at Perth Amboy and brought it to the scene of operation in the Ford. The Ford was provided with a hundred-gallon gasoline tank and a fair capacity force pump was borrowed and belted to the engine on one of the duster trucks.

This was used to pump water from a creek and the cyanide treatment was begun.

A small beginning but under way finally, enabling the treating of between one and one-half and two acres of sod land, along ditches and roads, that was heavily infested with larvæ. June had passed into history, also eight days of July before the tractor arrived by express. The sprayer also arrived, but with some parts broken, so it had to be repaired before it could be used.

Oil and oil combinations had been tested in a small way as weed killers as the things ordinarily used were dangerous to live stock if they ate the treated grass or plants. Kerosene, alone, was ineffective but a mixture of cheap lubricating or summer black oil, using equal parts or 2 or 3 parts kerosene to 1 of black oil, gave promising results.

Fence rows full of poison ivy, sassafras, and weeds, food plants of the beetle were killed or could be set on fire and burned on warm breezy afternoons, even two or three days after they were sprayed.

Fire following the spraying does a clean job, but as oil could not be procured after July 1, due to the dry rider on the federal appropriation bill holding up available funds for this work, and New Jersey's funds for this work being appropriated, contingent to the use of the federal funds first, operations were handicapped for several months and oil treatment was abandoned.

A limited amount of federal funds were available for labor or the work would have stopped.

Dusting all food plants in a band one-half to one mile wide around the territory heavily infested by the beetles was begun July 14, and continued through July, August, and until September 16. One big Niagara dusting machine, pulled by the tractor, was in operation continuously, weather permitting, and as rain usually fell at night little hindrance was experienced from weather. When one duster went out of commission, the other one was pressed into service until the broken one could be repaired.

One hundred pounds of lime was mixed with 15 pounds of dry arsenateof lead and in a small dust mixing machine. Later, the amount of arsenate of lead was increased to 20 pounds to 100 pounds of lime.

The last few days of the dusting, 24 pounds of arsenate to 100 pounds of lime was used as a test on amounts of poison needed. The acreage dusted cannot be estimated with any exactness but the total territory covered in the dusting operations can be estimated approximately:

First treatment	4,000–4,500 acres
Second treatment	4,500–5,000 "
Third treatment	4,000–4,500 "
Fourth partial treatment	1,000 "
	13,500–15,000 "

Total area dusted, 13,500 to 15,000 acres which includes large tracts on which no dusting was done, such as hay fields, pasture lots and fields free from food plants of the beetle.

Difficulty was experienced in dusting the area rapidly enough to keep the food plants covered with poison. Weeds grow rapidly and Polygonum or smartweed and other weeds grow very rapidly during July and August. Dead beetles were found under poison-dusted asparagus and smartweed at different times throughout the season but in most cases, the effective kill was difficult to determine as poisoned beetles usually had enough strength left to bury themselves in the ground.

This made them almost impossible to find after they had eaten leaves of the dusted food plants.

Hand collecting was practiced throughout the season from July 1 to mid-September. Average catches for the day varied with the locality collected and with weather conditions. Collections made largely after 6.30 p. m. from July 5 to July 20 by Mr. Perry and myself totalled almost fifty quarts. Collections by the boys employed for this purpose and under Mr. Spayd's direction varied considerably, but the total season's catch was a little over four bushels of beetles. Counts of measured quarts ranged from 4,400 to 5,000 beetles to the quart or 150,000 to the bushel.

Fall treatment of the soil to destroy the larvæ by using cyanide of a strength of 1 ounce of NaCN in 12 gallons of water began the 16th of September, using the Ford and 100 gallon gasoline tank. Some momentous events happened preventing me from being on the ground during October excepting for a few days during the latter part of the month. Under Dr. Headlee's general direction Mr. W. O. Ellis took charge of the eradication work during my absence. A two-ton truck which had been wanted since June 1 arrived during October and a 600-gallon tank was secured and mounted on it, enabling the treating of one-third to one-half acre of land per day with sodium cyanide solution with this outfit. A street-sprinkling outfit was hired and the tractor and sprayer truck and tank was also put into service enabling the treating of three-fourths to one acre per day with the entire equipment.

Approximately seventeen acres of land was treated with the solution of sodium cyanide applying 15,000 to 25,000 gallons to the acre.

This includes the sod or grassy edges of drives, along roads, ditches, and several small fields of corn ground and grass land.

Normal rates of applying this sodium cyanide solution would require 110 pounds of sodium cyanide to the acre. Some territory treated this fall undoubtedly did not receive much over half of this amount per acre as the failure to get a kill on some fields indicated. A total of eleven acres should have used our entire stock of sodium cyanide, while between sixteen and seventeen acres were treated.

During the latter part of November, we borrowed a gang plow, hitched it to the tractor and plowed between seven and eight acres of land heavily infested with larvæ to determine if possible the effect of such treatment on the larvæ. These plots of land are of several different types of soil and had been cropped in clover, grass, rye, corn, parsley, weeds, and sod along ditches. Most of the ground was plowed 8 inches deep, but some small plots were plowed 12 to 14 inches deep. The 12–20 tractor handled the plows at this depth after four months of continuous service in this sandy region. Without this machine we

would have been compelled to abandon most of the work planned out in the spring, that required the use of horses for power.

The season's field operations closed with this work but all equipment is being overhauled and put in first-class running condition for the coming year's work. Also new equipment is being secured for use next spring.

Concerning the actual progress in the eradication of this pest during the past summer, I can only say that we have materially reduced the numbers there would have been had they been allowed to go on breeding unhindered. The data for comparison with last season is not sufficient as yet to pass judgment. True we have the beetle survey of 1917 after the 18th of August as made by Mr. Ellis and the beetle survey of this season from July 1 to frost. This indicates some spread but the survey map of beetle distribution up to August 10th, 1918, marks nearly the widest limit of this year's range of distribution insofar as I can determine.

The larval survey of last June will not bear comparison with a survey made during October and November, 1918, for according to Mr. Ellis larvæ were present in the fall of 1917 in considerable numbers where none or very few could be found last spring. Furthermore we did not make a complete survey of the entire district supposed to be infested by the beetle. Not until a thorough larval survey is made in the spring of 1919 can a definite statement be made and even then seasonal variation may explain many differences.

Lack of proper and sufficient equipment on the ground in time to permit accomplishing more than part of the necessary eradication work, together with shortage of expendable funds at the time they were most needed, prevented getting the best results—in fact almost blocked the season's work.

VARIATIONS IN THE LENGTH OF THE FLAXSEED STAGE OF THE HESSIAN FLY[1]

By James W. McColloch, *Associate Entomologist, Kansas Agricultural Experiment Station*

A knowledge of the length of the flaxseed stage is of great importance in the development of a system of control for Hessian fly. It is in this stage that the fly withstands extreme conditions, such as excessive heat and drought of summer, and prolonged cold of winter. There is relatively little published data on the length of this stage,

[1] Contribution No. 40 from the Entomological Laboratory, Kansas State Agricultural College. This paper embodies some of the results obtained in the prosecution of project No. 8 of the Experiment Station.

although most of the writers recognize that a great variation exists. Enoch[1] (pp. 350–351) reports rearing flies from barley screenings that had been held two years in dry surroundings. Marchal,[2] in his work in France, was able to rear six broods of flies in the course of a year. He found that most of these broods were partial and that there was a tendency for some of the flaxseed of each generation to hold over until a latter generation. He advanced the idea that the species is perpetuated, in spite of the obstacles placed in its way by exterior conditions, by the great variability of its biologic cycle. Webster (p. 261),[3] quoting from Lindemann, says that the puparia (in Russia) are greatly influenced by environment, temperature, etc., and this is probably true of the other stages. Flaxseed collected by Lindemann in the spring of one year lived over to the spring of the following year. How far the number of these interlopers is augmented by a retarded development of greater or less extent it is impossible to say, but that there is an accession through this means there can be no doubt. Marlatt (p. 2)[4] states that under exceptional conditions the insect may remain dormant in the flaxseed state for a year or more and still bring forth the adult, a provision of nature which is doubtless intended to prevent the accidental extermination of the species. Webster (p. 11)[5] says, "Under exceptional conditions, such as in a dry room, flaxseed may be kept for a year or, even two, but when moistened the flies will soon emerge. So in the fields they will, during a drought, remain in the flaxseed state for a considerable time after they would appear under normal conditions, and only appear soon after rains have moistened the soil." Numerous other writers make similar statements, but data on actual rearings are very meager.

During the past six years much of the writer's time has been spent in a study of the life economy of the Hessian fly under Kansas conditions. Numerous rearings have been made in the field, in the breeding chambers of the air conditioning machine described by Dean and Nabours,[6] in the field insectary and from fly-infested material collected

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[1] Enoch, F. 1891. The Life History of the Hessian Fly, *Cecidomyia destructor*, Say. Trans. Ent. Soc., London, for 1891, pp. 329–366.

[2] Marchal, Paul. 1897. Les Cecidomyia des Céréales et leurs Parasites. Ann. Soc. Ent. France, Premiere trimestre, 1–105.

[3] Webster, F. M. 1899. The Hessian Fly. Ohio Agri. Exp. Sta., Bul. 107, pp. 257–288.

[4] Marlatt, C. L. 1900. The Hessian Fly. U. S. Dept. Agri., Div. Ent., Cir. 12, pp. 1–4.

[5] Webster, F. M. 1906. The Hessian Fly. U. S. Dept. Agri., Bur. Ent., Cir. 70, pp. 1–16.

[6] Dean, G. A., and Nabours, R. K. 1915. A New Air Conditioning Apparatus. Journ. Econ. Ent., 8: 107–111.

in the field. It is not the purpose of this paper to go into detail concerning the experimental work, since it is planned to present the complete studies in bulletin form at some future time. Certain points, especially with regard to the length of the flaxseed stage, seem to be of enough importance to warrant publication at this time as they have a direct bearing on the control of this insect.

The results of these studies show that the length of the various stages of the Hessian fly are extremely variable and consequently there is a great variation in the length of the life cycle. The exact length of the life cycle has been determined for over 900 individuals and the approximate length has been found for 8,500. While variations have occurred in each stage (Table 1), the greatest difference has been in the flaxseed stage where it has ranged from 7 days to 1,083 days. The minimum life cycle of 20 days was obtained under a constant temperature of 70° and humidity of 70 per cent, while the maximum cycle of 42 months was the result of studies in the field insectary and rearings from infested material kept in emergence boxes.

TABLE 1. SHOWING THE EXTREMES OF THE LIFE CYCLE

Stage	Maximum	Minimum
Egg	12 days	3 days
Larva	182 days	9 days
Flaxseed	1,083 days	7 days
Adult	6 days	4 hours
Life cycle	1,283 days	20 days

In order to determine the length of the flaxseed stage, under field conditions, clumps of infested wheat or stubble were collected at all seasons of the year from various localities of the state and placed in pasteboard rearing boxes. Each box had at least one glass tube into which the flies were attracted by the light on emerging. These boxes were kept in the field insectary under practically natural temperature conditions. The moisture, however, varied from that in the field. The material was thoroughly moistened when placed in the boxes. It was also moistened three times during each year: (1) in the spring when the first spring rains occurred; (2) in midsummer, and (3) in the fall when the fall rains began. Being of pasteboard, the boxes also absorbed some of the atmospheric moisture and they were also subject to wetting by beating rains. In all, over 150 collections of infested material have been under observation, and most of the material has been held for at least three years before being discarded.

While the data obtained in such an experiment can only be approximate, it has yielded some very interesting results. The fact that this

material was collected in the field makes it impossible to know the age of the flaxseed at the time they were included in the experiment, and the data are, therefore, summarized, in Table 2, to show the number of days between collection and emergence. Flies to the number of 7,461 were reared from this collected material and the average time between collection and emergence was 113.2 days, with extremes of 2 days and 1,083 days. It will be noticed that 5,114 flies, or 68.4 per cent, emerged during the first month, and 7,385, or 98.9 per cent, during the first year. On the other hand, 1.1 per cent of the flies did not emerge until after the first year, although they were subjected to the same conditions. If such conditions prevail in the field, and 1 per cent of the flaxseed hold over from one to three years, it serves to explain the sudden appearance of the fly in some areas where it was thought to be eliminated, and it emphasizes the importance of taking care of all stubble fields. Experiments are now being conducted to determine whether the fly does hold over for such long periods in the field. Thus far flies have been reared in fairly large numbers from stubble that has stood undisturbed for eighteen months in the field. Living flaxseed are still to be found in this stubble, indicating that further emergence may occur during the spring of 1919.

TABLE 2. SHOWING THE PERIOD BETWEEN COLLECTION AND EMERGENCE OF FLIES

Days After Collection	No. Flies Emerging	Days After Collection	No. Flies Emerging
1- 29	5,114	390–419	1
30- 59	399	420–449	2
60- 89	78	450–479	3
90–119	525	480–509	14
120–149	268	510–539	15
150–179	571	540–569	0
180–209	106	570–599	1
210–239	21	600–629	0
240–269	2	630–659	9
270–299	32	660–689	3
300–329	191	690–719	6
330–359	78	720–809	0
360–389	15	810–839	6
		1,083	1
		Total	7,461

NOTE: On May 7, 1919, the writer reared a female Hessian fly from a clump of wheat collected May 8, 1915. Allowing approximately a month for the fly to reach the flaxseed stage, this gives a life cycle of at least 49 months.

DOES BORDEAUX MIXTURE REPEL THE POTATO LEAFHOPPER?

By CHARLES L. FLUKE, JR., *University of Wisconsin*

At various times in the past the attention of our entomologists has been called to serious outbreaks of the potato leafhopper and for many years a more or less serious trouble has occurred on potatoes known as tip burn. A serious outbreak of the latter trouble appeared throughout a part of the country in 1918. This trouble happened in Wisconsin to such an extent as to decrease the potato crop at least 25 per cent. The potato leafhopper was also extremely abundant and observations have shown that the burning was always worse in the presence of a notable number of leafhoppers. It then became easy to associate the tip burn injury of this year with the leafhoppers and many observations were made in this connection. While carrying on experiments with Bordeaux mixture in combination with certain arsenicals for the control of the potato beetle, it was noticed that the plants sprayed with Bordeaux mixture were abnormally free from tip burn. Observations made at the time also showed that the leafhoppers were not abundant on these plants. Thirty plots in all were used in a series to test out various insecticides on Early Triumphs and Rural New Yorkers.

The first application of spray was put on July 10 at which time the plants were in good condition to show the effect of the insecticides. No curling or darkening of the leaves was apparent at this time, and it happened that only one plot of Early Triumphs received a Bordeaux combination spray. The other plots on which Bordeaux combinations were used were late potatoes. Daily observations were carried on to note the effect of these sprays on the foliage. Three days afterward (July 13) a peculiar darkening, not a drying, of the edges and tips of the leaves of the early potatoes was noticed on some of the plots which at first appeared to be due to the action of the spray until it was noticed that this also occurred on the check plots. At the same time considerable curling of the leaves was also observed. A few days later the characteristic burning of the leaves appeared on most of the Triumph plots. The only one which showed very little of the browning was one plot of four rows sprayed with zinc arsenite plus Bordeaux mixture 4–4–50. On July 23 a careful examination of the vines revealed the fact that the leafhoppers were extremely numerous wherever the tip burn was evident. On the above mentioned Bordeaux zinc plot the number of hoppers was comparatively smaller. It was plainly evident that the leafhoppers were very likely the cause of the tip burning and also that Bordeaux mixture had some repellent effect upon the hoppers. The counts were made on July 31 and August 1. The leafhoppers were more abundant on the sprayed plants in the rows next to those

unsprayed, than they were on sprayed plants which were at least six or eight feet away from the check plots.

It should be noted that by August first the check plants of the Early potatoes were in an advanced stage of tip burn while the Bordeaux zinc plot was still healthy with but little tip burning. This plot held up from a week to two weeks longer than the others. When the counts were made the hoppers on these plants were nearly all in the first instar. Of the late varieties there was a decided difference in appearance between the checks and those receiving Bordeaux mixture, the latter vines appearing much healthier. Tip burn appeared in a greater or less degree on all the plants but showed most on the early checks. In all cases the plants sprayed with Bordeaux mixture were healthier and gave higher yields than did the checks or those receiving Black Leaf 40. The nicotine sulfate, however, failed to kill the leafhoppers due mostly to the curling of the leaves. Further experimentation is needed to prove the repelling action of Bordeaux on the leafhoppers but these few observations are given to show future possibilities.

SPRAY TESTS AGAINST THE POTATO LEAFHOPPER, 1918

Plot No.	Insecticide		Material Added		Date of Application	Variety	Counts		Results		
	Name	Rate	Name	Rate			Nymphs	Adults	Total Hoppers	General Results	Remarks
6a	Bordeaux	4-4-50	Calcium arsenate	2½-50	July 10 and July 27	Late Rurals	162	7	169	Very little tip burning until late in season	Plant 3 feet from checks
6b	"	"	"	"	"	"	82	3	85	"	Plant 20 feet from checks
13a	"	"	Zinc arsenite	"	"	Early Triumphs	175	2	177	July 25—In much better condition than checks. Aug. 1 beginning to show tip burn	Hoppers nearly all just hatched. Next to check
13b	"	"	"	"	"	"	28	8	36	"	6 feet from checks
22	"	"	Lead arsenate	"	July 24	"	9	0	9	Spray applied late still in better condition Aug. 1 than plot 21	Next to plot 21
21	Black Leaf 40	23cc. to 5 gals.	"	"	"	"	335	35	370	B. L. 40 killed very few hoppers due to curled leaves	Next to plot 22. Tip burn severe
30	Check					Rurals	421	47	468	Tip burn appeared about Aug. 1–5	3 feet from early potatoes
31	"					"	177	19	196	"	20 feet from early potatoes
32	"					Early Triumphs	496	46	542	All died early	Next to sprayed vines
33	"					"	260	35	295	"	8 feet from sprayed vines

Total hoppers counted on 5 sprayed plants..... 476
Total hoppers counted on 5 unsprayed plants..... 1,871

NOTES ON LEPIDOPTEROUS BORERS FOUND IN PLANTS, WITH SPECIAL REFERENCE TO THE EUROPEAN CORN BORER

By Edna Mosher

The advent of the Eufopean corn borer, with its tremendous possibilities for injury if ever introduced into the great corn-growing states, has caused us to become much more concerned about the identity of the various caterpillars found feeding inside the parts of plants. The identity of the plant gives little help in this connection, since the corn borer has a very wide range of food plants and seems anxious to add to the list of those already known. Since lepidopterous larvæ vary considerably in their different stages as to colors and color patterns, and there are many with black or brown prothoracic shields and similar colors at the bases of the setæ, it is necessary to go farther than this in their identification. Easy keys are not available for the identification of such species and this paper is offered in the hope that it may aid field workers and others to be reasonably certain whether or not they have found the European corn borer. Of course the matter would be greatly simplified if we could include all the known species of borers in this country, but since material for such a study is now impossible to obtain, let us hope that our search for corn borers will bring to light, not only species hitherto described, but new life histories as well. It is appalling to think how little we know of the life histories, parasites, etc., of this single genus Pyrausta, whose one renegade member is costing us, not only great amounts of money but a great deal of time and anxiety as well.

Classification of Borers

Lepidopterous borers, in the main, belong to a few families. Nearly all of the species are provided with five pairs of prolegs, four abdominal and one anal, and these are armed with chitinous hooks or crochets. When these are absent the adfrontal area (Fig. 13, no. 29, *adf.*) and the median spine-like spinneret on the labium will distinguish them from larvæ of any other order. This paper does not include leaf-miners, borers in woody plants, or gall-making species.

The character found most reliable so far in the determination of lepidopterous larvæ is the arrangement of setæ on the various body segments. Some other characters have been used, and it seems quite possible that there are others available. In separating the families mentioned here, the arrangement of setæ on the prothorax and of the hooks on the prolegs are sufficient for the majority of cases. The

prothorax nearly always has a chitinized shield on the dorsum which, in most species, does not extend as far ventrad as the spiracle. This area of the thorax properly has six setæ on each side, two of these, one cephalic (seta I) and one caudal (seta II) are usually quite near the median line. The figures show the left side of the prothorax from the median line of the dorsum to that of the venter. Beside these dorsal setæ is a group found nearly always between the spiracle and the cephalic margin of the segment, but sometimes a little ventrad of the spiracle. Farther ventrad is a group, usually of two setæ, between the spiracular group and the coxa. Near the coxæ, usually between them and the median line of the venter, is one, or possibly two setæ, on each side.

The following families may be found in searching for corn borers:

a Prolegs may be represented by swellings but hooks are never present; thoracic legs may or may not be present; setal arrangement never as in Fig. 11, no. 13. *Prodoxidæ*

aa Prolegs, or at least crochets, nearly always present, if not, setal arrangement as in Fig. 11, no. 13. (See Gelechiidæ.)

b A group of three setæ in front of the thoracic spiracle.

c Prolegs with one complete circle of large hooks and numerous irregular rows of very small ones (Fig. 11, no. 2) ..... *Acrolophidæ*

cc Prolegs never with the small hooks as in Fig. 11, no. 2 and never with more than three rows.

d Hooks of prolegs arranged in two bands, one on each side of the proleg (Fig. 11, no. 6) ..... *Ægeriidæ*

dd Hooks of prolegs arranged in a complete circle (sometimes absent in Gelechiidæ).

e Of the four setæ nearest the median line on the dorsum of the ninth abdominal segment, the caudal two (setæ II) are closer together than on any other segment (Fig. 11, nos. 9, 10); body usually not tapering at the caudal end nor sharply constricted between segments ..... *Tortricidæ*

ee The four setæ on the dorsum not varying greatly in arrangement on the ninth abdominal segment; body usually tapering at the caudal end and often strongly constricted between segments { *Gelechiidæ* / *Œcophoridæ*

bb With two setæ in front of, or occasionally slightly below, the thoracic spiracle; one of the setæ often very weak or small so that it is not easily located.

c Hooks of prolegs arranged in a complete circle or one nearly complete (Fig. 12, nos. 16, 17, 25), never with a single row on the mesal margin .. *Pyralidæ*

cc Hooks of prolegs in a single row or band along the mesal margin (Fig. 14, nos. 37, 42) ..... *Noctuidæ*

Prodoxidæ.—The larvæ of this family are found only in Yuccas and are only likely to be confused with those Gelechiidæ which lack prolegs. The setal and ocellar arrangement should be enough to distinguish them and no gelechiid borer has been described from Yucca.

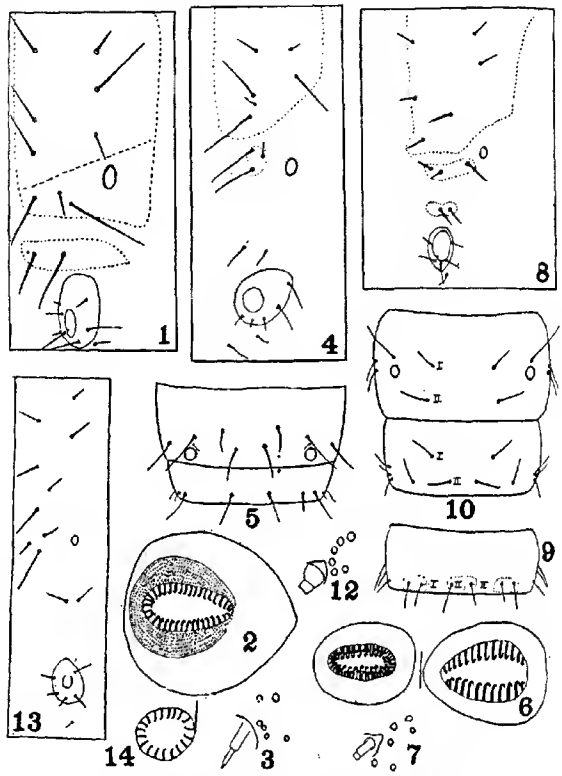

Fig. 11. 1, Acrolophidæ, *Acrolophus mortipennellus*, setal map of prothorax; 2, proleg of same; 3, ocellar arrangement; 4, Aegeriidæ, *Melittia satyriniformis*, setal map of prothorax; 5, eighth and ninth abdominal segments; 6, proleg; 7, ocellar arrangement; 8, Tortricidæ, *Eucosma* sp.?, setal map of prothorax; 9, ninth abdominal segment; 10, *Cacœcia* sp., eighth and ninth abdominal segments; 11, proleg; 12, ocellar arrangement; 13, Gelechiidæ, *Metzneria lappella*, setal map of prothorax; 14, proleg of unnamed species.

Acrolophidæ.—These are not true borers but have been taken in the bases of corn stalks while searching for Crambids. These larvæ are often picked up in fields in the fall while they are searching for a place to hibernate. Of the three species listed in the twenty-third Illinois report, one is much more common than the others, *Acrolophus arcanellus* (*Pseudanaphora arcanella*) (Fig. 11, nos. 1–3). The prothoracic

shield is very heavily chitinized on all these species and extends ventrad to include the spiracular group of setæ. The ocellar arrangement is also distinctive.

Aegeriidæ.—The only species of this family to be included here is *Melittia satyriniformis*, the squash-vine borer. The arrangement of hooks on the prolegs is distinctive (Fig. 11, no. 6) but figures of the prothorax, ocellar group and eight and ninth abdominal segments (Fig. 11, nos. 4, 5, 7) are given as a contrast to the Tortricidæ, to which this family is closely related.

Tortricidæ.—Several species of this family have been reported from various seeds and seed pods. The commonest genus found boring in stems is *Eucosma*, some members of which form galls. I have several species of this family which are as yet unidentified and figures of one of these from ragweed, which may be a species of *Eucosma*, are given. These (Fig. 11, nos. 8, 9) show the characteristic tortricid arrangement of setæ on the prothorax, also on the ninth abdominal segment. Another type of arrangement of the setæ on the ninth segment is shown in Fig. 11, no. 10. The ocellar arrangement (Fig. 11, no. 12) has been fairly constant in the species studied. The hooks on the prolegs are usually of two sizes but Fracker (Illinois Biological Monographs, Vol. 2, No. 1) states that in some Tortricids they are all of one size.

Gelechiidæ.—The majority of the larvæ of this family which live in plant stems form galls, and may be identified by Dr. Felt's excellent paper (N. Y. S. M. Bul. 200). The potato tuber moth, *Phthorimaea operculella*, is one which does not form galls, and an unidentified species of this genus has been taken many times in stems of giant ragweed and Silphium. *Metzneria lapella*, found in the fruits of burdock, and *Sitotroga cerealella*, the Angoumois grain moth, illustrate the type of gelechiid in which the prolegs are absent. The arrangement of setæ (Fig. 11, no. 13) will distinguish these larvæ from all others with the hooks of the prolegs arranged in a circle. Most of the boring species examined had hooks of one size (Fig. 11, no. 14) but many species in the family have them like the tortricids (Fig. 11, no. 11).

Œcophoridæ.—The commonest member of this family is the parsnip webworm, *Depressaria heracliana*, which, after feeding in the flower heads and among the seeds of various Umbelliferæ, and causing a characteristic webbing of the umbel, bores down into the stalk and pupates. The larvæ are true gelechiids, and were at one time included with them. Fracker remarks that "no satisfactory character has been found to separate them" and uses the arrangement of the ocelli which he finds unsatisfactory. The setal arrangement of *D. heracliana* is like that of the gelechiids (Fig. 11, no. 13) but it has proleg hooks of three sizes. It is yellow with black spots around the setæ, and the

abdominal segments show clear spaces much like *Pyrausta penitalis* (Fig. 13, no. 28, *b*).

Pyralidæ.—This family contains many injurious pests and among them several well-known borers. The larvæ are distinguished by the two setæ in front of the prothoracic spiracle, or slightly below it (Fig. 12, nos. 15, 18, 24) and the arrangement of hooks on the prolegs (Fig. 12, nos. 16, 21, 25) which are nearly always of three sizes, arranged in a complete circle, or in a broken circle, open at the lateral margin. In three of the subfamilies, Phycitinæ, Crambinæ and Pyraustinæ, are species with the boring habit. There is considerable individual variation in nearly all the species of this family making the classification exceedingly difficult. It will be impossible to make anything like a good classification, until a larger number of species have been reared. The following key will separate the principal genera.

a Hooks of prolegs arranged in a complete circle and of three sizes (Fig. 12, no. 16)
  b Adfrontal pieces reaching the vertical triangle (see Fig. 13, no. 29) which is very large; eight setæ present on each half of the ninth abdominal segment and not arranged in a straight line.....*Elasmopalpus*
  bb Adfrontal pieces not reaching the vertical triangle, which is of normal size; six setæ present on each half of the ninth abdominal segment, arranged in a straight line.
    c Spiracular setæ always below the level of the thoracic spiracle (Fig. 12, no. 18); body never with skin sculpturing, as in Fig. 13, nos. 33, 34, but smooth, nor with a chitinized spot caudad of the spiracle on each proleg-bearing segment (see Fig. 13, no. 28, *s. p.*) body always with prominent black or brown spots around the setæ.....*Diatræa*
    cc Spiracular setæ seldom below the level of the thoracic spiracle (Fig. 12, no. 15), usually at least one of them in front of it, if both are below the level of the spiracle then there is a very distinct chitinized mark caudad of the spiracle on each proleg-bearing segment; skin often with sculpturing as in Fig. 14, no. 33.....*Crambus*
aa Hooks of prolegs not arranged in a complete circle (Fig. 13, nos. 21, 25)
  b Setæ of prothorax and ocelli arranged as Fig. 13, nos. 20, 22; thorax distinctly narrowed towards the head, which is comparatively small.....*Diaphania*
  bb Setæ of prothorax and ocelli arranged as in Fig. 12, nos. 24, 26; thoracic segments of approximately the same width; head of normal size....*Pyrausta*

Phycitinæ.—The only member of this family likely to be met is *Elasmopalpus lignosellus*, the lesser cornstalk-borer. It is easily distinguished by the character given in the key, also by the peculiar striped and banded appearance. One of the setæ on the lateral surface of the ninth abdominal segment is small and weak and should not be overlooked. *Etiella zinckenella*, reported as boring in beans in the west, belongs here, but is comparatively rare. Another borer in the stems of beans, *Monoptilota nubilella*, forms galls, and is not considered here.

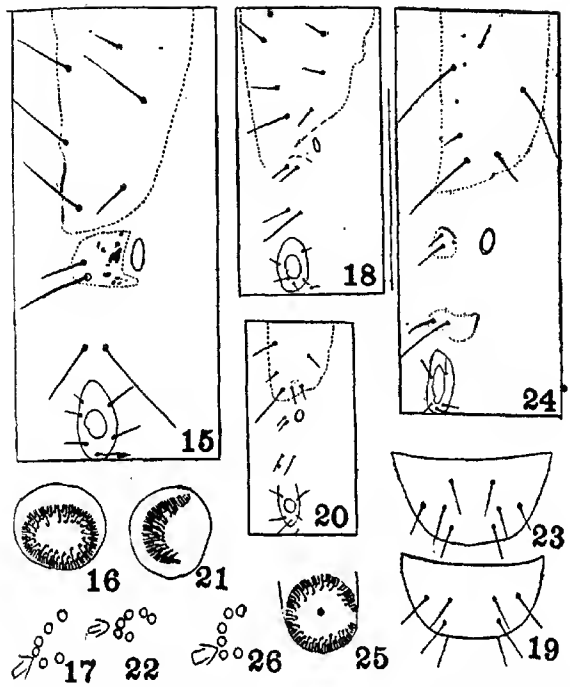

Fig. 12. 15, Pyralidæ, *Crambus* sp., setal map of prothorax; 16, proleg; 17, ocellar arrangement; 18, *Diatræa zeacolella*, setal map of prothorax; 19, tenth abdominal segment; 20, *Diaphania nitidalis*, setal map of prothorax; 21, proleg; 22, ocellar arrangement; 23, tenth abdominal segment; 24, *Pyrausta nubilalis*, setal map of prothorax; 25, proleg; 26, ocellar arrangement.

Crambinæ.—Many members of this subfamily resemble certain Pyraustinæ in many characters. The ocellar arrangement (Fig. 12, no. 26) and that of the setæ on the tenth abdominal segment (Fig. 12, no. 19) seem to be very constant characters, as well as those given in the key. Fracker states that some Crambids have the proleg hooks arranged in a broken circle like *Pyrausta* (Fig. 12, no. 25) but of two sizes instead of three. None of these have been found among the species under observation. In this subfamily the genus Crambus has a few species which are borers, and the genus Diatræa has two, the larger cornstalk-borer, *D. zeacolella*, and the sugar-cane moth borer *D. saccharalis cramboides*. Out of the large genus *Crambus* only four named species, *vulgivagellus*, *trisectus*, *leachellus*, and *hortuellus*,

were available and a considerable number of unnamed species. Each of these species could easily be separated from either of the species of *Diatræa* but genus characters are hard to find, owing to the great differences between some of the species, which seemed greater than those between certain of the species and *Diatræa*. In addition to the characters given in the key, there are certain cuticular markings, which may indicate sensory pores, that are always found in Crambus and never in Diatræa. On the chitinized area in front of the thoracic spiracle bearing the setæ, all Crambus species have certain markings, sometimes dark as in Fig. 12, no. 15, or at other times light, and somewhat transparent in appearance. Nearly all the species examined had the darkly chitinized spot caudad of the spiracle on the proleg-bearing segments much as those in Pyrausta (Fig. 13, nos. 27, 28, *s. p.*). On these same segments, and sometimes on others, a small circular or oval area was always found mesad of setæ I. Similar markings are also found in Pyrausta (Fig. 13, nos. 27, 28), but always dark-colored; while those in Crambus are generally pale.

Pyraustinæ.—In addition to the characters given in the key this subfamily may be distinguished by the arrangement of setæ on the tenth abdominal segment (Fig. 12, no. 23), and the different arrangement of the ocelli (Fig. 12, no. 22, 26). Specimens of the genus *Phlyctænia*, which sometimes bores into stalks of celery, have not yet come to hand, so this genus is reluctantly omitted. *Diaphania nitidalis*, the pickle worm, and other species of the genus may easily be separated by means of the key and Fig. 12, nos. 20–22. Out of six species of Pyrausta examined, four of them namely—*nubilalis*, *penitalis*, *illibalis* and *futilalis*—only two seem very closely related, *P. nubilalis*, the European corn borer, and *P. penitalis*, a borer in Polygonum and other weeds. Specimens from the Illinois State Natural History Survey labeled *P. nelumbialis*, now a synonym for *penitalis*, do not resemble other material of this species. They are considerably larger, fully one-third longer, with much finer skin sculpturing, the spiracles more than twice as large, and no trace of certain minute setæ found on both *penitalis* and *nubilalis*. This species varied from other species studied by the characteristic skin sculpturing shown in Fig. 13, nos. 33 and 34. This is considerably coarser in *penitalis*. The two species, *penitalis* and *nubilalis*, are so closely related that they are very difficult to separate. Since *penitalis* occurs in the region infested by the corn borer, and also infests corn, it is important to be able to separate them.

One of the easiest characters is the chitinized shield of the tenth abdominal segment, which is usually truncate along the anterior margin in *penitalis*, as in Fig. 13, no. 32, and with a rounded projection at the cephalo-lateral angle but this character is not reliable, since many

individuals show it with an emargination as in *nubilalis* (Fig. 13, no. 31) and less often with the sharper cephalo-lateral angle usually found in that species. The anterior dorsal setæ (setæ I) on the eight abdominal segments are, like most of the setæ, situated on dark tubercles which are often almost contiguous in *penitalis*, separated by a distance usually much less than the width of the tubercle, while the distance is usually much greater in *nubilalis*, but these vary somewhat. Another useful character, if its variations could be well described are the clear areas of the abdominal segments. These are shown contrasted in Fig. 13, nos. 27 and 28 and again in Fig. 13, nos. 31 and 32. These are always very distinct on each side of the median line on abdominal segments 2–8 in *penitalis*, each space oval, and nearly every space well bounded and separated from the next one, so as to give a row of them a distinctly moniliform appearance. Segments 3–7 usually show these rows of spaces divided into two sections, near the middle of the row, the space between varying in different segments (Fig. 13, no. 28). While these spaces may vary slightly as to number or degree of separation between individual spaces, there is a remarkable uniformity in all the segments. This is never true in *nubilalis*. After studying a large series of specimens, nothing approaching the regularity of *penitalis* was discovered. This species seldom shows anything but an irregular clear strip, but occasionally the spaces on one or two segments will seem to be quite distinct, but this arrangement will be different on other segments. The arrangement of spaces in *nubilalis* is shown in Fig. 13, no. 27 and they are seldom more distinct. When a skin is cleared and mounted the clear spaces in *penitalis* remain unchanged, while the nearest approach to this arrangement in *nubilalis* showed only a clear band, with no subdivision into individual spaces. There is a prominent furrow caudad of the anterior tubercles in *penitalis*, ending at the sensory pore. In *nubilalis* there are many more clear spaces in this location.

The setal arrangement on the head varies in the two species. The anterior setæ and punctures (*ant. 1*, *2 ant. P*) have a very constant arrangement. In *penitalis* (Fig. 13, no. 30) they are not in line, the second seta being farther laterad than the first seta and the puncture. In *nubilalis* the setæ and puncture are nearly in line, with the puncture a little laterad. The adfrontal setæ and punctures offer some help in determination, their position in *penitalis* being fairly constant, with the second adfrontal always below seta *P* (Fig. 13, no. 30). The setæ in *nubilalis* are more variable in their arrangement, being sometimes much like *penitalis* with the second adfrontal opposite seta *P*, rarely below it. In many individuals they are as far dorsad as in Fig. 13, no. 29 which represents the extreme in that direction.

The skin sculpturing is of some help, being apparently very constant

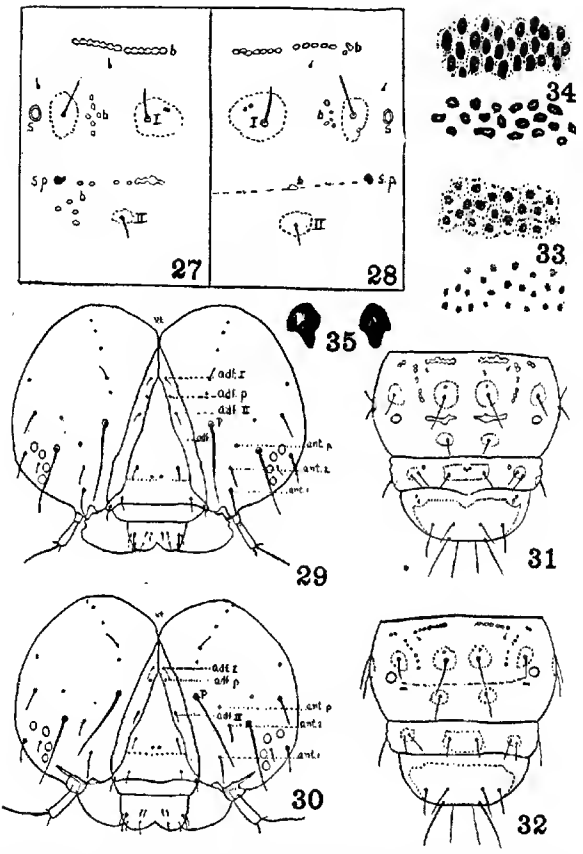

Fig. 13. Comparison of structures, *Pyrausta nubilalis* and *P. penitalis*. 27, *P. nubilalis*, left side, dorsum fourth abdominal segment, *I*, seta I; *II* seta II; *b*, clear spaces; *s*, spiracle; *s. p.*, sensory pore?; 28, same segment, *P. penitalis*; 29, *P. nubilalis*, cephalic aspect of head, *adf.* adfrontal area; *adf. I*, *adf. II*, adfrontal setæ; *adf. p.* adfrontal puncture; *P*, large seta of epicranium; *ant. 1*, *ant. 2*, anterior setæ; *ant. p.*, anterior puncture; *v. t.*, vertical triangle; 30, *P. penitalis*, cephalic aspect of head; 31, *P. nubilalis*, abdominal segments, 8–10; 32, *P. penitalis*, same segments; 33, *P. nubilalis*, skin sculpturing, upper half from between setæ of dorsum, fourth abdominal segment; lower, from below spiracle; 34, *P. penitalis*, skin sculpturing from same locations; 35, sensory pores? enlarged.

in *penitalis* as shown in Fig. 13, no. 34. In a very few instances the arrangement in *nubilalis* was found to approach that of *penitalis*, but the majority of cases showed the sculpturing as in Fig. 13, no. 32.

The sensory pores (Fig. 13, no. 35 *s. p.*) are usually more elongate in *nubilalis*, but vary in the two species.

The remaining species either had conspicuous black or brown spots around the bases of the setæ, as in *P. futilalis* and *P. illibalis*, or very pale yellowish ones. None of these had the chitinized marks (sensory pores) caudad of the spiracles on the proleg-bearing segments as in the previous group. *P. futilalis* has very large hooks on the prolegs and these extend around about two-thirds of the circumference. The labrum is more deeply notched than any of the others and the spiracles are decidedly oblong, edged with a prominent black chitinous ring. The full-grown larvæ average 25 mm. in length. *P. illibalis* is distinguished by the very small prolegs often with black tips. These bear very much smaller hooks than any of the others and when these are retracted the end of the proleg outside the hooks is seen to be covered with minute spines. The labrum is notched like *futilalis* but edged with a band of black. The spiracles are nearly circular with a narrow pale brown ring. The average length of a mature larva is 20 mm.

Noctuidæ.—There are quite a number of noctuid borers and all easily recognized by the characters given in the key. Several species of this family, such as *Arzama obliqua* and *Nonagria oblonga*, which normally bore in the stalks of the cat-tail, have been reported from corn. Other noctuid borers are the iris borer, *Macronoctua onusta*, certain species of Hadena reported from corn, *Chloridea virescens* which attacks tobacco, etc. Of all the species of noctuid borers, there were only available, *Papaipema nitela*, the common stalk borer, *P. furcata*, *P. nebris*, and *P. cataphracta*, *Heliothis obsoleta*, the corn ear worm and *Achatodes zeæ*, the spindle worm. These genera may be easily separated by the figures given of each. The stripes on *P. nitela*, the commonest borer, are not always very distinct, especially in the younger stages. The sixth seta on the shield (Fig. 14, no. 43 *a*) and the second spiracular (Fig. 14, no. 43 *b*) are usually very weak or wanting. This genus has been carefully studied by Mr. Henry Bird who has written descriptions of many species of larvæ. *H. obsoleta* often bores in stalks and the young stages look considerably like the European corn borer, and has been found in stalks infested by them. The skin sculpturing (Fig. 14, no. 39) is distinctive, no matter what the coloration. It consists of large spiny cuticular appendages, with alternating small spines, while minute ones fill up the spaces. *Achatodes zeæ* is always white with small black spots around the setæ, and the most easily recognized of all the noctuid borers. It is found in a variety of plants

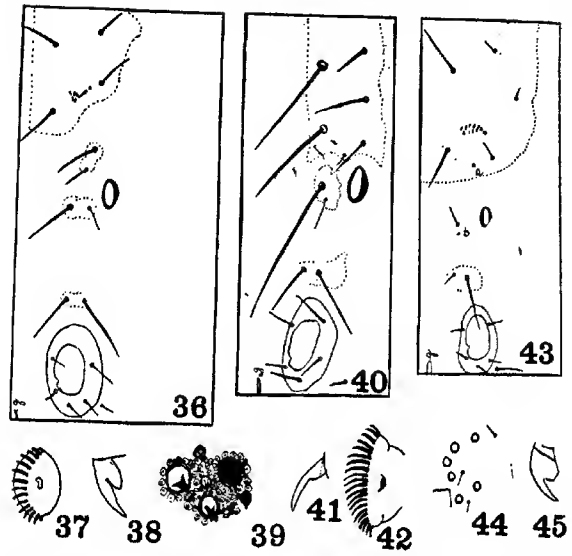

Fig. 14. 36, Noctuidæ, *Heliothis obsoleta*, setal map of prothorax; 37, proleg; 38, tarsal claw; 39, skin sculpture; 40, *Achatodes zeæ*, setal map of prothorax; 41, tarsal claw; 42, proleg; 43, *Papaipema nitela*, setal map of prothorax; 44, ocellar arrangement, typical of Noctuidæ; 45, tarsal claw.

and when mature averages 35 mm. The prothoracic gland is found in all of these noctuids, the slit where it is everted is represented in Fig. 14, nos. 36, 40, 43 *g*.

I am greatly indebted to the following persons for loans and gifts of material and some of them have given valuable suggestions: Dr. E. P. Felt, Dr. W. E. Britton, Dr. Edith M. Patch, Dr. H. Garman, Mr. D. J. Caffrey, Mr. George G. Ainslie, Mr. C. P. Alexander, Mr. Henry Bird, Mr. Philip Luginbill and Mr. T. H. Parks.

Scientific Notes

Notes on Some Insect Pests of Costa Rica. During the latter part of February and March of this year, while in Costa Rica for a vacation, a few observations were made of the insect pests of that country. As the most serious of the pests do not as yet occur in the United States, a few notes on them will be of more than casual interest.

The most important "find" was, no doubt, the "mosca prieta" or spiny citrus whitefly (*Aleurocanthus woglumi* Ashby). It was very abundant on citrus of various species at Limon and at all the stations of the Northern Railroad as far as Peralta. At Cartago, at an elevation about one mile, it was not found. The degree of infestation was worse than it is in the Canal Zone. The trees were so heavily infested as to be readily noticeable from the car windows. This whitefly occurs probably all through Central America and tropical South America, particularly along the Atlantic seaboard. From questions asked of the customs and port authorities, and from actual observations, it would appear that this insect gained access to Costa Rica from small sailing vessels coming from San Andres and other islands of the Caribbean. It seems to be an inborn custom of the islanders to carry potted plants wherever they go. Thus far fifty-two hosts, representing twenty-six families of plants, have been recorded for *A. woglumi*, among them being the various species of citrus, mango, star-apple, cashew apple (marañon), papaya, chirimoya, mamei, plantain, and coffee.

The purple scale, *Lepidosaphes beckii* Newm., and sooty mould were extremely abundant on both leaves and fruit of citrus.

Another bad pest was the Hawaiian sugar-cane borer, *Rhabdocnemis obscurus* Bois. It was exceedingly abundant at Zent, C. R., in banana stumps and cuttings. As many as forty adults were taken out of a small piece of stalk about a foot long. Dr. W. D. Pierce, in his Manual of Dangerous Insects, cites the following hosts for this weevil: banana, sugar-cane, cocoanut, sago palm, royal palm, wine palm, and papyrus. The important observation here was a few adults were found crawling on the leaves of banana, showing that this serious pest can very easily be introduced into the United States among the banana leaves used as packing for fruit on boats calling at New Orleans.

At Limon, and awaiting boats for shipment to the United States, were about a hundred flat cars loaded with Balsa logs, and, from data obtained, these were here from one to four weeks. Under the bark of these logs were found a number of lepidopterous larvæ and pupæ. The great majority of the logs were infested with several species of borers, specimens of which have been sent to the Bureau of Entomology for identification. These borers were very active and abundant. As the determinations are lacking at present writing, it is impossible to say whether they are already present in the United States. However, the degree of infestation and the ease with which such logs can enter the United States, makes the introduction of such pests a certainty, and it is time to pay attention to the possibilities of this source of danger. Otherwise many new and dangerous pests will unquestionably be added to our already large list of insect-immigrants.

JAMES ZETEK, *Ancon, Canal Zone.*

A Source of Confusion in the Diagnosis of Nosema apis in Adult Bees. In March, 1917, the writer received for diagnosis from Cabarrus County, North Carolina (Samples Nos. 5324 and 5325), a sample of dead bees and two brood frames containing honey, pollen and a few dead bees with heads in cells. These frames were from the colony from which the dead bees had been taken, the colony having shown marked symptoms of dysentery earlier in the season with many bees dying. Microscopic examination of the large intestines from several of the dead bees macerated in salt

solution showed large numbers of highly refractile oval bodies strongly resembling the spores of *Nosema apis*, the microsporidian parasite sometimes associated with adult diseases of bees.

To determine whether any of these spore-like bodies might he present in the honey of the colony from which the dead bees were taken, several square inches of comb, containing sealed cells of honey hut no apparent pollen cells, were cut from the frames and the honey was squeezed therefrom through cheesecloth. This honey was a clear dark amber color having a peculiar somewhat bitter flavor and a disagreeable odor. On standing a yellow scum came to the surface, containing a large amount of pollen.

Several grams of this honey were dissolved in about 30 cc. of distilled water and centrifuged. Microscopic examination of the residue under a cover glass in a water mount and with the high power dry lens, showed what was apparently a large number of *Nosema apis* spores and also many unidentified pollen grains of various shapes, large round ones predominating however. After accidentally crushing some of these pollen grains under the cover glass it was found that several of the large round fairly smooth grains seemed to be packed full to overflowing with these refractile spore-like hodies. Also the microscopic field had become crowded with countless numbers of these hodies.

A second lot of honey was treated in the same manner, only this time the residue was washed several times with salt solution. Microscopic examination showed the same appearance particularly after crushing with the cover glass.

Next, pollen from cells in the comb from which the honey had been taken was examined in a water mount in the same manner. These same spore-like bodies were found to be present only in much smaller numhers until the pollen grains were crushed as before when the spore-like bodies again appeared in large numbers.

Pollen grains from combs taken at random from several different sources were then examined but no such appearance was found in any of the samples examined.

Stained smears from the intestinal contents of the dead bees and also from the residue after centrifuging the diluted honey gave no results as these hodies seemed to have disappeared or been destroyed during the process of staining. Finally, some Gram's iodine solution was run in under the cover glass of a water mount of some of this material. Almost immediately these spore-like bodies turned a deep purple color and the pollen grains containing them turned almost hlack giving what appeared to be a typical starch reaction. It was then found, aided by the kindness of the pollen laboratory of the H. K. Mulford Company of Glen Olden, Pa., that these pollen grains were from corn and that although this is the most striking example of the presence of starch granules in pollen grains, most of the cereal grains show the same condition, but they are not found in pollen of other families.

These starch grains upon measurement and comparison with the size and appearance of the actual *Nosema apis* spores were found to have just about the same measurements and shape although the shape of starch grains was a little more variable, often being more nearly round than the typical long oval.

Furthermore, it has been found experimentally that such materials as starch and dextrin are indigestible to bees, causing what might he called acute indigestion or auto-intoxication. Therefore, the presence of so much indigestible starch in the pollen food of the bees was probably a contributory factor if not the actual cause of the dysentery and death of so many of the adult bees in this particular instance cited.

Starch granules have since been found in a few samples received for examination. Therefore, it has since then been the custom after making a preliminary microscopic examination, to treat with iodine solution in the above manner all material from samples sent in for diagnosis of adult diseases, in order to prevent possible future confusion. This precaution should be taken in all such examinations.

ARNOLD P. STURTEVANT, *Bureau of Entomology.*

A Note on Temperature in Relation to *Sciara coprophila* Lintner. In the winter of 1918 an outbreak of *Sciara coprophila* Lintner interfered with an experiment in which Dr. W. H. Burkholder of the Department of Plant Pathology of Cornell University was testing the growth of beans at three constant temperatures. The experiment was carried on in three parts, one at a temperature of 91° F., another at 76° F. and a third at 60 to 65° F. The moisture content of the pots was kept uniform by the use of Livingston auto irrigation. The beans grown in soil at a temperature of 91° were uninjured, but those growing in earth at 76° were seriously damaged while some at the lower temperatures of 60° to 65° were slightly attacked. The air temperature of the greenhouse varied between 70° and 80° F.

To regulate the evaporation, the pots in which the beans were planted were covered with paraffine paper and a paper cylinder was placed around the plant to prevent the paraffine coming in contact with the stem. Adults of Sciara were found entering these cylinders and laying eggs in the moist earth to which manure had been added as a fertilizer; later when the paraffine covers were removed, large numbers of flies were liberated; eggs, larvæ and pupæ also were found commonly present in the soil of the pots. The beans were in a weakened condition, many of the lateral roots having been eaten off and the taproot itself attacked.

Although these data were obtained by chance, they tend to indicate that the optimum soil temperature favorable to the reproduction of the fly is near 76° F. and below 91° F. Evidently infestation may take place in soil that has a temperature of 60 to 65° F., but apparently this is not the most favorable temperature for the continued and abundant increase of the insect.

I. M. Hawley,
Department of Entomology, Cornell University.

Handbook or Compendium. An entomologist's handbook or compendium is very much needed, especially by economic entomologists. It is planned to compile such a handbook, which will include principles and methods of studying the life-histories of insects, of conducting field experiments and demonstrations, handy tables for field workers, etc. It is desired to have references, or better, to have separates of all published notes dealing directly or indirectly with the subject and to have details, and if possible drawings or photographs as well, of cages, apparatus, methods, etc., as yet unpublished. The handbook will be a compilation and full credit given to all contributions.

The coöperation of entomologists is solicited.

John J. Davis, *Box 95, West La Fayette, Indiana.*

Commercial Entomology. A recent manual of spraying, issued by a company which prepares spray materials and which is illustrated by colored plates, gives a figure on the plate of the San José Scale labeled "egg of female" and another labeled "egg of male"!

This is a contribution not only to entomology but indeed to natural history as a whole. It is to be hoped that some parts of this manual, at least, are more reliable than this.

H. T. F.

Lachnosterna crassissima (Blanch). Three adults of this species were in the stomach of a channel catfish (*Ichtalurus punctatus*) caught in a small stream in southern Kansas, July 6, 1918. In the stomach of second fish was a handful of wheat grains. Two adult *L. fusca* (Froelich) were in the stomach of a crappie (*Pomoxis annularis*) caught in June, 1911, in the same small stream.

E. G. Kelly,
Extension Entomologist, Kansas State Agricultural College.

A New Monophlebine Coccid from Borneo. Many years ago Westwood described a male Monophlebid from the Gulf Coast, West Africa, remarkable for the red costal region of the wings. In 1915 Prof. C. F. Baker sent me an insect of this type from the island of Palawan, in the Philippines. I now have before me a third species, also from Professor Baker, represented by two specimens from Sandakan, Borneo (Baker 9615). It may be described as follows:

Llaveia hæmatoptera n. sp.

Male similar in nearly all respects to *L. sanguinea*, from Palawan, but differing thus: (Larger, wings 8 mm. long, expanse 18 mm.; head and thorax warm reddish, without black or piceous; eyes bright red, not dark; the six fleshy processes of abdomen very long, the last about 3.5 mm.

The three species are readily separable as follows:

Thorax red; larger species.....*hæmatoptera* Ckll
Thorax at least mainly black or piceous above; smaller species.....1
1. Caudal tassels not half width of abdomen.....*raddoni* (Westwood)
Caudal tassels much over half width of abdomen.....*sanguinea* Ckll.

T. D. A. COCKERELL,
University of Colorado.

The San José Scale in the Argentine Republic. Mr. Juan Bréthes of Buenos Aires sends me a Coccid, remarking that it is certainly new to the Argentine Republic, but doubtless known from elsewhere. It is indeed, for it is *Aspidiotus perniciosus* Comstock. I have written urging that measures to taken to eradicate it, if it is not too late. T. D. A. COCKERELL.

Army worm. (*Heliophila unipuncta* Haw.) The search this spring for European corn borer larvæ, *Pyrausta nubilalis* Hubn., in portions of New York state, resulted in finding in cornstalks in early April partly grown army worm caterpillars. They were then nearly three fourths of an inch long and although more highly colored and usually rather distinctly striped, presented a somewhat general resemblance to the true corn borer. These caterpillars were found in soft or punky corn stalks, evidently having entered simply for shelter. They were so numerous in sections about Ballston that seven or eight of these larvæ were frequently found to one or two of the true corn borer. It was this insect and not the corn borer which was found at Schuylerville, Saratoga County. The identity of these young army worm larvæ was not fully established until early in May at which time more characteristically colored, half grown caterpillars were found in similar situations.

The above record in relation to army worms is entirely new for New York state and is of particular interest in view of the statements published by Mr. Vickery[1] relative to the tropical or subtropical origin of this species and his belief that it was problematical if it would survive a mild winter as far north on the Atlantic coast as the city of Washington. It is true that the past winter has been exceptionally mild and this may be the reason why the species lived through in the vicinity of Saratoga, though it should be remembered that corn fields in New York state have never been examined so carefully as during the past few months and this latter may be the real reason why the larvæ were found. It is certain that the army worm occurs annually here and there in the state and this fact, taken in connection with its known survival of the winter of 1918–1919, leads us to believe that it may withstand the rigors of our climate more successfully than is suggested in the above cited article.

E. P. FELT.

[1] Journal Economic Entomology, 8:390, 1915.

Anthrenus verbasci Linn., a Seventeen-Year Breeding Record. April 4, 1902, two ears of popcorn, infested by this insect, were received and placed in a two quart Mason jar and the latter kept tightly closed with no moisture aside from that in the somewhat dried corn. Breeding has continued apparently uninterrupted for seventeen years, namely to April 4, 1919, at which time a living larva was found and there are presumably others alive, either adults or larvæ, though June 26, 1918, rather close search failed to disclose anything living. In the spring of 1909 (JOURN. ECON. ENT., 2:193) the bottom of the jar was nearly covered with fine, white, globose particles, apparently starch grains, fallen from the eaten kernels of corn and there was a thick mass of brown larval skins and other débris. Conditions were practically the same in the spring of 1912 (JOURN. ECON. ENT., 5:297) except that there was more débris. There then remained much uneaten corn and the same is true at the present date, April 4, 1919, except that breeding appears to be reduced to a minimum, though not from any scarcity of food. There would seem to be no reason why breeding may not continue under these conditions for a considerable series of years, unless the strain has become depleted through continued inbreeding.

Those interested in the ability of Dermestidæ to adapt themselves to untoward conditions are referred to the very interesting account by J. E. Wodsedalek (*Science*, 46:366–67, '17) in which he records the curious results following five years of starvation of larvæ of *Trogoderma tarsale*, which resulted in a gradual decrease in the size of the larvæ, the size shrinking, even to the hatching length, and increasing with the scarcity and abundance of food respectively.

E. P. FELT.

Regarding Personal Credits in Farmers Bulletins of the U. S. Bureau of Entomology. Until early in 1916 the custom of publishing personal credits was uniformly observed in the Farmers Bulletins issued by the Bureau of Entomology of the United States Department of Agriculture. About that time, however, a change in departmental policy occurred respecting such matters, and the custom was discontinued. The object in view in making this change was to render the included matter more acceptable to the class of readers for whom it was intended. It was held that such persons have no interest in the personnel of the originating organization back of such publications, and that the inclusion of personal credits tended to detract from the brevity and directness of appeal of such publications.

That this view of the matter has much in its favor cannot be denied, but it is also true that the custom of omitting personal credits has sometimes given rise to adverse criticism, especially from persons who do not understand the attitude of the department in this matter. A case in point is the recent issue of Farmers Bulletin 1046 on the European corn borer under the authorship of Mr. D. J. Caffrey, who conducted the bureau's portion of the investigations of this recently discovered pest. A large portion of the biological investigations in connection with this work was performed by the late Mr. Stuart C. Vinal under the direction of the Massachusetts Agricultural College. Mr. Vinal was personally responsible for the original discovery of the insect, and conducted the preliminary investigations entirely alone, and it may even be said without exaggeration that he sacrificed his life for the success of the work by remaining at his post of duty for several days while suffering from the illness which caused his death.

L. O. H.

Turkeys and Chinch Bugs. Apropos to the recent discussion in this JOURNAL, on the enemies of the chinch bug (Flint, Oct., 1918, and McColloch, Feb., 1919), I wish to record an observation made at Edwardsville, Ill., June 10, 1917. Two to three weeks old turkeys, foraging in a wheat field near a farm house, became busily engaged eating the mature chinch bugs which were numerous in the wheat. The young turkeys searched eagerly for the bugs, ate them with apparent relish, and by many actual counts the individual bird picked them up at the rate of more than thirty a minute.

March 31, 1919. JOHN J. DAVIS.

IMPORTANT NOTICE

At the Baltimore meeting of this association it was voted that the price of the JOURNAL OF ECONOMIC ENTOMOLOGY should be fixed by the executive committee. Recognizing the large increase in cost in producing this publication, the committee has voted to increase the subscription price to all subscribers $1.00 per annum, beginning January 1, 1920. After that date, rates will be as follows:

Subscription price to members, $2.50 per annum.

An additional charge of 50 cents will be made to foreign members to cover cost of postage.

Subscription price to non-members, $3.50 per annum.

Subscription price to foreign subscribers, $4.00 per annum.

The annual dues of members of the association have not been increased and will remain as heretofore, namely:

Active members, $1.50. Associate members, $1.00 per annum.

A. F. BURGESS, *Secretary.*

Melrose Highlands, Mass.
May 23, 1919.

EUROPEAN CORN BORER CONFERENCE

Hon. Charles S. Wilson, New York State Commissioner of Agriculture, plans, as President of the Association of State Commissioners of Agriculture, calling a conference of Commissioners of Agriculture and Entomologists in particular to discuss and if possible formulate a National Policy in regard to this most serious pest. The conference will probably be held at Albany, N. Y., the last of August and will afford an unexampled opportunity to ascertain the latest facts in regard to the situation. It is very desirable for entomologists from all corn states to attend, because, in the ultimate analysis, they must have a very important part in determining this policy and the promotion of a sentiment in favor of a comprehensive and satisfactory program. E. P. FELT.

JOURNAL OF ECONOMIC ENTOMOLOGY

OFFICIAL ORGAN AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

JUNE, 1919

The editors will thankfully receive news items and other matter likely to be of interest to subscribers. Papers will be published, so far as possible, in the order of reception. All extended contributions, at least, should be in the hands of the editor the first of the month preceding publication. Contributors are requested to supply electrotypes for the larger illustrations so far as possible. Photoengravings may be obtained by authors at cost. The receipt of all papers will be acknowledged.—Eds.

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Last winter entomologists of the northeastern United States found themselves confronted with a serious problem, namely the positive identification of a destructive Pyraustid caterpillar at a time when the comparatively harmless larvæ of allied species were practically unknown. Pyraustids have not occupied a conspicuous place as economic insects and have for the most part been left alone by economic entomologists. They have not proved particularly attractive to systematists. This is specially true of the larvæ. The conditions occurring last winter may easily be duplicated in other groups, though no one can indicate with any great degree of assurance the group of insects likely to be troublesome next. These facts suggest the need, and this is recognized by most entomologists, of a more symmetrical or general knowledge of the insect fauna as a whole. There are many earnest students engaged in solving problems and, unfortunately in some cases at least, there has been undesirable concentration upon a few groups at the expense of others which do not at the time appear so important or seem specially attractive. The present is an excellent time to consider this lack of method for the country as a whole and to see if some practical way cannot be found to overcome the difficulty. An intelligent distribution of effort would greatly lessen the probability of a recurrence of conditions such as obtained last winter. Would it not be possible for the specialists in various lines to suggest the groups requiring particular attention and when these are pointed out it might be feasible to work through our national organizations and secure a distribution of these problems to those willing to undertake such

studies, provided they were assured of reasonable time and freedom in which to complete the investigations. A little planning and coördination along such lines would do much, we believe, to produce a well rounded and comprehensive total of knowledge relating to American insects in all stages.

Reviews

Outlines of Economic Zoology, by A. M. REESE, pages I to XVII, 1 to 316, 194 illustrations. P. Blakiston's Son & Company, 1919.

The author correctly states that the study of insects is a large department of science in itself and owing to the difficulty of doing the subject adequate justice within the narrow limits of a small volume, he has confined himself largely to a discussion of a few disease-carrying insects, some of the more common household pests, the honey bee and the silk worm. The greater part of the book is devoted to very concise and interesting discussions of the economic relations of the other members of the animal kingdom and as such will prove of value to the entomologist who desires a recent summary of this character. (*Adv.*) E. P. F.

Canadian Bark Beetles, Part I, Descriptions of New Species, Part II, A Preliminary Classification, with an Account of the Habits and Means of Control, by J. M. SWAINE, Dominion of Canada, Department of Agriculture, Entomological Branch, Bulletin 14, Part 1, pages 1 to 32, 1917, and Part II, pages 1 to 143, plates 31, 1918.

The first part of this important work is limited mostly to descriptions of new genera and new species and in the second part we have a comprehensive and most excellent classification of Canadian bark beetles, illustrated by a series of exceptionally fine figures showing not only structural details of many of the bark borers but also depicting characteristic workings of a number of species. This publication gives within a brief compass, an admirable summary of this important and very destructive group of beetles. The text and illustrations show the work of a man who has had both field and laboratory experience and is, therefore, in a position to discuss the subject matter in the most illuminating manner. (*Adv.*) E. P. F.

Studies on the Fruit Flies of Japan; Contribution I, Japanese Orange Fly, by Doctor TSUNEKATA MIYAKE. Reprint from Imperial Central Agricultural Experiment Station in Japan, Bul. II, No. 2, pages 85 to 165, plates 10, 1919.

This is a monographic study of the Japanese fruit fly, described as *Dacus tsuneonis*, the author giving a detailed discussion of both the external and internal structure of the adult, a similar study of the larva and numerous details in regard to the habits, life history and methods of controlling this species. Several associated or allied forms are also characterized. The author is to be congratulated upon the comprehensive character of his work and it is to be hoped that contribution I will be supplemented by other equally valuable studies. (*Adv.*) E. P. F.

Successful Spraying, by E. H. Favor, Hayes Pump and Planter Company, Galva, Ill., 127 pages. Price, $1.00.

It is not often that a spraying manual published by a company engaged in the manufacture of spraying machinery or insecticides is worthy of serious notice. This volume is an exception to the rule. Publications of this kind have a wide circulation and reach many who do not read the bulletins of the experiment stations (even where available). It is, therefore, gratifying to note that in the present instance sound and practical advice is presented in concise and attractive form. The text is clearly written and fairly well illustrated. In Chapter I the importance and value of spraying is clearly set forth and many practical suggestions are given as to methods. Chapter II deals with insecticides and fungicides, their preparation and uses. In Chapter III the common insect pests of orchard, vineyard, and garden are briefly described, the life history outlined and the proper treatment indicated. Chapter IV is devoted to plant diseases. Chapter V, "How to Spray," contains spraying schedules for various crops and directions for applying whitewash and disinfectants by means of the spray pump. In Chapter VI are many valuable suggestions as to use of the spray pump in disinfecting seed grain, in spraying hogs and cattle, in disinfecting poultry houses, and in killing weeds. Chapter VII is devoted to the spraying of citrus trees and the last chapter, also VII, treats of the spraying of shade trees.

The book has surprisingly few errors for a publication of this kind. "Black Leaf 40" tobacco extract does not contain 40 per cent nicotine sulfate as stated on page 28, but many official entomologists have fallen into the same error. (*Adv.*) C. R. C.

Current Notes

Conducted by the Associate Editor

Mr. Hugh Knight has been appointed assistant in entomology at the citrus substation, Riverside, Cal.

Prof. S. A. Forbes, state entomologist of Illinois, visited various points along the Atlantic Coast, the first week in May.

Lieut. R. V. Truitt of the Aviation Service is assistant in entomology and zoölogy at the Maryland State College of Agriculture.

Dr. J. M. Aldrich has been appointed honorary custodian of diptera in the United States National Museum in succession to the late Frederick Knab.

According to the "Review of Applied Entomology," Mr. G. F. Hill has been appointed entomologist of the Queensland Institute of Tropical Medicine, Townsville, North Queensland.

Dr. C. H. T. Townsend, specialist in the United States National Museum, Washington, D. C., has accepted a position in Brazil as official entomologist to the Sao Paulo State Government.

Mr. Charles H. Richardson, recently a research chemist with the Rohn and Haas Chemical Company, Bristol, Pa., has been appointed specialist in insect physiology, Bureau of Entomology, Washington, D. C.

Dr. W. A. Riley, of the University of Minnesota has been appointed a member of the joint committee of research of the Association of American Agricultural Colleges and Experiment Stations

According to *Science* Lieut. A. C. Chandler, assistant professor of zoölogy at the Oregon Agricultural College, has been ordered to the front with the American soldiers to make a study of the rat parasites in France.

Dr. Robert Kirkland Nabours, professor of zoölogy and curator of the natural history museum at the Kansas Agricultural College, was recently elected president of the Kansas Academy of Science at its fifty-first annual meeting.

Prof. Franklin Sherman, Jr., and Mr. R. W. Leiby of the Division of Entomology, North Carolina Department of Agriculture, have both been sick with influenza followed by pneumonia. Both are now again on duty, though Professor Sherman has not yet fully recovered.

Mr. R. L. Webster, who holds an industrial fellowship at Cornell, is stationed at Geneva, N. Y., for the summer, working in coöperation with Prof. P. J. Parrott. During the winter Mr. Webster spent a month in Florida, studying the fumigation of citrus fruits in that state.

The following Bureau employees have returned from service in Army and Navy and have been reinstated in the Bureau: Lieut. W. H. Larrimer; Lieut. W. H. White; C. A. Weigel; Lieut. John A. Monteith, Jr.; Max W. Reeher; W. D. Whitcomh; F. L. McDonough; W. E. Dove; A. B. Jarrell; W. B. Cartwright; M. J. Kerr; R. B. Willson.

The Connecticut legislature has just adjourned after increasing biennial appropriations for entomological work as follows: for state entomologist, $15,000 from $12,000; for suppressing gipsy and brown-tail moths, $70,000 from $40,000; for inspecting apiaries, $4,000 from $1,500; for European corn borer, $10,000. A law has also been enacted requiring beekeepers to register with the town clerk in each town.

Mr. M. B. Dunn, temporary assistant at the Dominion Entomological Laboratory at Fredericton, N. B., has been appointed an entomological assistant in the Division of Forest Insects of the Entomological Branch, Ottawa, and, under the direction of Dr. J. M. Swaine, he will be assigned to sample plot investigations in the forests of Quebec and Ontario.

Mr. C. E. Pemberton, Bureau of Entomology, who followed Dr. Back in charge of the fruit-fly station and quarantine service in Hawaii, and who has been for the past year in war service in Honolulu, has been released from the Army and has accepted a position with the Hawaiian Sugar Planters' Association at a material financial betterment.

The following resignations in the Bureau of Entomology are announced: L. J. Hogg, cereal and forage insects, Arizona; Charles F. Stiles, apicultural extension work, Oklahoma; M. S. Linebaugh, L. P. O'Dowd, and E. A. McGregor, southern field crop insects; O. D. Link, truck crop insects, Florida; J. S. Stanford, cereal and forage crop insects; Q. S. Lowry, truck crop insect extension in Massachusetts; R. F. Wixson, special agent in apiculture for Virginia.

A conference on the subject of the gipsy and brown-tail moth quarantine was held May 6 at Washington. A. F. Burgess reported that this year there will he no need of an extension of the quarantine lines and in fact notable reductions can be made in some places. There was no necessity, therefore, for a public hearing.

Mr. J. M. Robinson, graduate of Ohio State University, became assistant entomologist at the Alabama Polytechnic Institute on January 1, 1919. Professor Robinson has charge directly of the class work in entomology and zoölogy. With the appointment of Professor Robinson, Dr. Frank L. Thomas became extension entomologist, and will devote at least half of his time to extension phases of entomological work in the state of Alabama.

Mr. D. C. Warren, formerly of the Alabama Polytechnic Institute, resigned January 1, 1919, to accept a position as assistant entomologist with the Georgia State Board of Entomology. Now Mr. Warren is located at Valdosta, Ga., and is expecting to conduct this year, especially, tests in the control of boll weevil by the use of calcium arsenate and other arsenicals. The tests will be conducted particularly with Sea Island cotton.

A coöperative investigation of the wireworms attacking cereal crops has been arranged between the Bureau of Entomology and the Washington State Agricultural Experiment Station. The Bureau has agreed to furnish a man who will be stationed in central Washington during the growing season of the year, to conduct the Bureau's portion of this coöperative work. F. R. Cole of the Forest Grove (Ore.) station has been assigned to this project for the present.

According to *Science* Maj. William B. Herms, associate professor of parasitology in the University of California, has resumed his university duties. Major Herms served with the Sanitary Corps of the United States Army for a little over a year, and since April, 1918, was stationed at the port of embarkation at Newport News, Va., where he was in charge of malarial drainage operations, delousing stations, and assisting in general sanitary inspection.

Mr. Edw. Doubleday Harris died at his home in Yonkers, N. Y., on March 2, after a few days' illness, in his eightieth year. He was born in Cambridge, Mass., September 30, 1839. He collected and studied the beetles of the family Cicindelidæ and several years ago presented his collection to the Museum of Comparative Zoölogy at Cambridge, Mass. In 1911, he published and distributed at his own expense, a small pamphlet entitled *North American Cicindelidæ in the Harris Collection.*

The following appointments are announced in the Bureau of Entomology: Douglas R. Royder, inspector sweet potato weevil work; J. N. Tenhet and S. F. Grubb, scientific assistants, tobacco insects; George G. Becker, agent for extension work, deciduous fruit insects, Arkansas; George B. Fisher, and G. W. Curtin, scientific assistants, Arlington, Mass.; J. Edward Taylor, alfalfa weevil demonstrations, Utah; Dr. R. S. McEwen, temporarily as artist; Wesley L. Miles, Arlington, Mass.; William Yetter, scientific assistant codling moth investigations, Grand Junction, Colo.; Dr. C. H. Richardson, insect physiologist, Washington, D. C.; Harry H. Stage, stored product insect investigations; Mortimer D. Leonard, extension work in truck crop insects in New York state.

Mr. Leonard S. McLaine, M. Sc., of the Canadian Entomological Branch, has been transferred from the Dominion Entomological Laboratory, Fredericton, N. B., to Ottawa, and has been appointed chief of the Division of Plant Inspection and executive assistant to the Dominion Entomologist. As chief of the Division of Plant Inspection, Mr. McLaine will have immediate charge of the work of inspection and fumigating imported nursery stock and of the field work against the brown-tail moth in eastern Canada and such other duties as the enforcement of the insects and pests regulations under the Destructive Insect and Pest Act may involve.

Recent transfers in the Bureau of Entomology are as follows: R. J. Fiske, Federal Horticultural Board to cereal and forage crop insect investigations, and assigned to work on the southern corn rootworm at Columbia, S. C.; C. F. Stahl, truck crop insects, Spreckels to Riverside, Calif.; W. H. Dumont, southern field crop insect investigations, Augusta, Ga., to Wilmington, N. C., and later to Mound, La.; R. W. Kelley, extension work with deciduous fruit insects in Indiana, to the Insecticide and Fungicide Board, and assigned to the laboratory at Vienna, Va.; E. E. Wehr, exten-

sion agent, insects injurious to domestic animals, Maryland to Indiana; W. H. Larrimer, cereal and forage insects in charge of field station, West Lafayette, Ind.; C. M. Packard from Berkeley, Calif., to have charge of field station at Hagerstown, Md.; M. C. Lane, Forest Grove, Ore., to Berkeley, Calif.; D. J. Caffrey, Hagerstown, Md., to Arlington, Mass., in charge of investigations on the European corn borer; E. J. Newcomber and W. D. Whitcomb to Yakima, Wash., to a new field station for the study of the codling moth and other deciduous fruit insects; E. R. Selkregg and B. R. Leach to Dover, Del., where a new laboratory has been established for study of the codling moth; C. H. Alden to Wallingford, Conn., C. K. Fisher, formerly at Wellington, Kan., to Wichita, Kan.; W. B. Turner, Hagerstown, Md., to Arlington, Mass.; F. L. Simanton, Benton Harbor, Mich., to Monticello, Fla.; W. A. Hoffman, Monticello, Fla., to Brownwood, Tex.; E. H. Siegler, Wallingford, Conn., to Washington, D. C.; A. O. Larson, extension work in deciduous fruit insects to Alhambra, Calif., to investigate pea and bean weevils in California; F. B. Milliken to Dallas, Tex., where a laboratory will be established for the study of the species of *Tribolium* and other mill pests.

The European corn borer work has been reorganized under Cereal and Forage Insect Investigations of the Bureau, with separate headquarters for the investigational and control activities. Investigational headquarters are located at No. 10 Court St., Arlington, Mass., and this work is now in full swing. The personnel at present is as follows: D. J. Caffrey, assistant in charge; H. E. Smith, entomological assistant; R. H. Van Zwaluwenburg; G. B. Fisher, W. B. Turner, C. W. Curtin, scientific assistants; J. H. Moore, field assistant; F. L. Pendergast, stenographic clerk; G. F. Greene, laborer. L. H. Worthley, formerly engaged under A. F. Burgess as agent in preventing spread of moths, has been placed in charge of the control work, with headquarters at 43 Tremont St., Boston, Mass. This phase of the work for the present will be carried on mainly under a fund especially appropriated by the state of Massachusetts in coöperation with the State Department of Agriculture. Saul Phillips has been appointed as assistant under Mr. Worthley for the field work, and entered upon his new duties on April 15. Mr. Phillips has had fifteen years of experience in insect control work in eastern Massachusetts, including gipsy and brown-tail moth work, and also considerable experience in mosquito control on the North Shore. He is, therefore, well equipped to handle the work which has been entrusted to his care. A force of 400 men was put to work cleaning up in the infested area on April 15, when the special state appropriation of $30,000 became available. It is expected that this work subsequently will be provided for by the Federal Government, if Congress agrees to allow a suitable appropriation for the work. Several methods of attacking the insect have been proposed, and are now being given a thorough trial. In view of the short period of time available before the moths emerge from their winter quarters, it probably will not be possible to treat effectively the entire infested area this spring.

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